PUBLIC HEALTH ASSESSMENT

LAKE CITY ARMY AMMUNITION PLANT
[(a/k/a LAKE CITY ARMY AMMUNITION PLANT (NORTHWEST LAGOON)]
INDEPENDENCE, JACKSON COUNTY, MISSOURI

EPA FACILITY ID: MO3213890012

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Agency for Toxic Substances and Disease Registry

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LIST OF ABBREVIATIONS

ATSDR	Agency for Toxic Substances and Disease Registry
B_2EHP	bis(2-ethylhexyl)phthalate
BDCM	bromodichloromethane
bgs	below ground surface
CDBM	dibromochloromethane
CPF	cancer potency factor
CV	comparison value
DCE	(1,2) 1,2-dichloroethylene
DCE	(1,1) 1,1-dichloroethylene
EPA	U.S. Environmental Protection Agency
EWI	Explosives Waste Incinerator

FS	feasibility study
HU	hydrostratigraphic unit
IA	initial assessment
IWTP	Industrial Wastewater Treatment Plant
LCAAP	Lake City Army Ammunition Plant
LOAEL	lowest observed adverse effect level
MPVE	multi-phase vapor extraction
MRL	ATSDR's minimal risk level
OU	operable unit
PAH	polycyclic aromatic hydrocarbons
PA/SI	preliminary assessment/site investigation
PAS	public availability session
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
PHAP	public health action plan
ppb	parts per billion
ppm	parts per million
PRW	permeable reactive wall
RfD	EPA's reference dose
RDX	royal demolition explosive (cyclotrimethylene trinitramine)
RI	remedial investigation
ROD	record of decision
SDWS	safe drinking water standards
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TCE	trichloroethylene
USACHPPM	United States Army Center for Health Promotion and Preventive Medicine
VOCs	volatile organic compounds

ATSDR Glossary of Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, **1-888-422-8737**.

En Español

A B C | D E F | G H I | J K L | M N O | P Q R S | T U V | W X Y Z

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Additive effect
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with antagonistic effect and synergistic effect].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Aerobic
Requiring oxygen [compare with anaerobic].

Ambient
Surrounding (for example, *ambient* air).

Anaerobic
Requiring the absence of oxygen [compare with aerobic].

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect
A biologic response to exposure to multiple substances that is **less** than would be expected if the known effects of the individual substances were added together [compare with additive effect and synergistic effect].

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study
A study that uses (a) biomedical testing or (b) the measurement of a substance [an analyte], its metabolite, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see exposure investigation].

Biologic monitoring
Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing
Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden
The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP [see Community Assistance Panel.]

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Case study
A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number
A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic
Occurring over a long time [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

Cluster investigation
A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP)
A group of people from a community and from health and environmental agencies who work with ATSDR to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect
A disease or an injury that happens as a result of exposures that might have occurred in the past.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention
Measures used to prevent a disease or reduce its severity.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD
United States Department of Defense.

DOE
United States Department of Energy.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism

Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance [see Public health surveillance].

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure registry
A system of ongoing followup of people who have had documented environmental exposures.

Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds
Training sessions for physicians and other health care providers about health topics.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Half-life ($t_{½}$)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Health promotion
The process of enabling people to increase control over, and to improve, their health.

Health statistics review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

In vitro
In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with in vivo].

In vivo
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with in vitro].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Medical monitoring
A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

mg/cm^2
Milligram per square centimeter (of a surface).

mg/m^3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous

substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

Morbidity
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

Mutagen
A substance that causes mutations (genetic damage).

Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or **NPL)**
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Toxicology Program (NTP)
Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

Physiologically based pharmacokinetic model (PBPK model)
A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica
A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume

A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb
Parts per billion.

ppm
Parts per million.

Prevalence
The number of existing disease cases in a defined population during a specific time period [contrast with incidence].

Prevalence survey
The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard

A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement
The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public health surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Public meeting
A public forum with community members for communication about a site.

Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide
Any radioactive isotope (form) of any element.

RCRA [see Resource Conservation and Recovery Act (1976, 1984)]

Receptor population
People who could come into contact with hazardous substances [see exposure pathway].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].

Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD [see reference dose]

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or an environment.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Substance-specific applied research
A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's toxicological profiles. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund [see Comprehensive Environmental Response,

Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Surveillance [see public health surveillance]

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].

Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-

adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:
Environmental Protection Agency EXIT
National Library of Medicine (NIH) EXIT

PUBLIC HEALTH ASSESSMENT

LAKE CITY ARMY AMMUNITION PLANT
[(a/k/a LAKE CITY ARMY AMMUNITION PLANT (NORTHWEST LAGOON)]
INDEPENDENCE, JACKSON COUNTY, MISSOURI

SUMMARY

The Agency for Toxic Substances and Disease Registry (ATSDR) prepared this public health assessment (PHA) to evaluate exposure pathways and to respond to community concerns about past, current, and potential future exposures to contaminants originating at Lake City Army Ammunition Plant (LCAAP). After considering the most currently available information, ATSDR found that contaminant releases at LCAAP do not pose a public health hazard. ATSDR has categorized this site as a "No Apparent Public Health Hazard" because exposure to contaminants in groundwater and from air emissions in the past may have occurred (see definition in Table 1).

LCAAP is an active plant covering approximately 3,955 acres in Jackson County, Missouri. LCAAP, originally called Lake City Arsenal, has been in continuous operation since 1941, except for a 5-year period between World War II and the Korean War. The plant was originally established as a government-owned, contractor-operated military installation to produce small caliber ammunition. LCAAP is entirely fenced and access to the plant is restricted.

A number of chemicals are used in the plant's production process including detergents, bleaches, explosive compounds (e.g., lead azide and lead styphnate), petroleum and lubricating oils, and trichloroethylene (TCE) and other solvents. Previous wastewater EXIT treatment and solid waste disposal practices at LCAAP relied on unlined lagoons EXIT, landfills, and burn pits. These past practices resulted in contamination of soil, groundwater, and some surface water bodies at the plant.

ATSDR conducted a site visit at LCAAP in 1999. ATSDR viewed the areas of contamination, met with LCAAP representatives, and gathered information used to evaluate potential public health hazards from exposure to environmental contaminants. ATSDR did not identify any completed exposure pathways requiring immediate action. The primary community health concern involves potential groundwater contamination and drinking water quality. In this PHA, ATSDR evaluates potential exposures to groundwater, soil, surface water and sediment, and air.

Following a 1985 preliminary assessment/site investigation, LCAAP was divided into 33 study areas. These areas are currently grouped into three operable units (OUs): the Area 18 OU, the Northeast Corner OU (Areas 11, 16, and 17), and the Installation-Wide OU, which includes all other study areas. The U.S. Environmental Protection Agency EXIT placed LCAAP on the National Priorities List of hazardous waste sites in 1987 because of groundwater contamination in Area 3. Each of the areas of contamination has been investigated. A final record of decision (ROD) for the Area 18 OU and an interim ROD for the Northeast Corner OU have been released. An interim remedial action ROD for metals contaminated soil for the Installation-Wide OU is expected to be signed in the Fall 2001. As of the release of this report, LCAAP has not proposed a schedule for completing a final ROD for the Installation-Wide OU.

ATSDR reviewed available on-site groundwater data. Chemicals in on-site monitoring wells detected at levels above ATSDR's health-based comparison values (CVs) include volatile organic compounds (VOCs) (e.g., TCE, 1,2-dichloroethylene, and vinyl chloride), metals (e.g., lead, manganese, and arsenic), and some explosives (e.g., cyclotrimethylene trinitramine (royal demolition explosives) [RDX] and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (high melting explosives).

Groundwater beneath LCAAP is used as a potable drinking water source. The plant obtains its drinking water from 13 active on-site supply wells. TCE and vinyl chloride have been and continue to be detected above their CVs in three of the plant supply wells. A former supply well, currently being used as a groundwater extraction well, contained high levels of vinyl chloride and 1,2-dichloroethylene. Eight supply wells are currently connected to five air strippers, installed between 1988 and 1990, that are designed to remove VOCs. Recent drinking water tests at LCAAP have met state and federal standards for safe drinking water.

Although exposures to some VOCs may have occurred in the past, it is unlikely that these exposures occurred at levels of health concern because most of the supply wells that were used for drinking water at LCAAP were not contaminated. No individuals consumed water exclusively from the supply wells that were found to contain VOCs. The water from all the supply wells is blended and stored in a large (500,000 gallon) holding tank where any VOCs would be significantly diluted. ATSDR concludes that past exposures to on-site contaminants in drinking water supply wells posed no public health hazard. Because past exposure was possible, however, ATSDR has categorized this pathway as a "No Apparent Public Health Hazard." On the basis of currently available data and the ongoing water treatment, ATSDR concludes that exposure to contaminants in on-site drinking water poses no current or future public health hazards.

The Installation-Wide OU groundwater plumes are contained on site and are not expected to migrate beyond the plant's perimeter. The Area 18 OU and the Northeast Corner OU contain groundwater plumes that are near or just beyond the northern perimeter of the plant. VOCs, lead, and cadmium have been detected in a few private wells located to the north of these source areas at levels exceeding their CVs. ATSDR evaluated data from private drinking water wells and determined that VOCs and metals have not been present at levels of health concern. *On the basis of currently available data, ATSDR concludes that exposure to contaminants in private drinking water wells poses no past, current, or future public health hazards. ATSDR has categorized this pathway as a "No Apparent Public Health Hazard" since exposure is still possible in the future.*

ATSDR reviewed available on-site soil data. VOCs, metals, explosives, and polycyclic aromatic hydrocarbons were detected in surface soil above their CVs at some study areas. Access to the plant, however, is restricted and the small housing area located in the southwestern corner of the plant is isolated and distant from the main industrial area where the areas of contamination are located. Under LCAAPs Facility Use Contract initiative, any proposed new land use at the Plant must be reviewed by LCAAP and the Operations Support Command. In addition, any proposed reuse of land must meet existing legal agreements and conditions, including land use restrictions and institutional controls. In addition, state (MNDNR) and federal (EPA) regulatory agencies are responsible for making sure that contaminated areas meet the applicable clean-up standards for the proposed land use. *On the basis of available data, ATSDR concludes that exposure to contaminants in soil poses no past, current, or future public health hazard.*

ATSDR reviewed on-site surface water and sediment data. VOCs, metals, and explosives (e.g., RDX) were detected above their CVs in some surface water and sediment samples. Most of the surface water and sediment samples taken were in close proximity to sources of contamination where exposures are unlikely to have occurred. Surface water and sediment samples collected off site did not contain contaminants above CVs. *From the available data, ATSDR concludes that exposure to contaminants in surface water and sediment poses no past, current, or future public health hazards.*

ATSDR also reviewed potential past exposures to air emissions from burning of explosive materials (i.e., wet pyrotechnics and propellant powder) and from VOC emissions from the sealing operations units at LCAAP. Exposures to VOCs and other air pollutants may have occurred in the past; however, there are no monitoring data to evaluate whether contaminants released into air were present at levels that were harmful. Most VOCs were released near the center of the plant, within the main industrial area, and it is unlikely that ambient air concentrations would have been high enough to pose a health hazard to residents living at the housing area on site or at off-site locations near LCAAP. At present, the sources of contamination either no longer exist or measures have been taken to reduce emissions. Open burning of explosive materials stopped in 1993 and VOC emissions are currently being controlled through source reduction measures. *For these reasons, ATSDR concludes that air contaminants in and around LCAAP pose* no public health hazard *for past, current, or future exposures.* For past exposures, ATSDR has categorized the air pathway as a "No Apparent Public Health Hazard" since exposures may have occurred in the past.

Table 1. ATSDR Hazard Categories for LCAAP

CONCLUSION CATEGORY	SITUATIONS/SITES
No Apparent Public Health Hazards	**A.** Past exposure to on-site groundwater at LCAAP (i.e., drinking water supply wells) **B.** Past, current, or future exposures to off-site groundwater (i.e., private drinking water wells) **C.** Past exposure to ambient air contaminants at LCAAP

No Public Health Hazards	**A.** Current or future exposures to on-site groundwater at LCAAP (i.e., drinking water supply wells) **B.** Past, current, or future exposures to soil contamination at LCAAP **C.** Past, current, or future exposures to surface water and sediment at LCAAP **D.** Current or future exposures to ambient air contaminants at LCAAP

BACKGROUND

Site Description and History

Lake City Army Ammunition Plant (LCAAP) is an active plant covering approximately 3,955 acres in Jackson County, Missouri. The plant is located near the eastern boundary of the city of Independence and is approximately 3 miles north of Blue Springs, 2 miles southwest of Buckner, and adjacent to Lake City to the north (Figure 1). The plant is bordered to the west by Missouri State Highway No. 7 and to the east by private residences and agricultural land. The plant is between U.S. Highway 24 to the north and U.S. Highway 70 to the south. A narrow unpaved road, Heidelburger Road, runs along the northern boundary of the plant. There are also railroad tracks that run along the northern perimeter of the plant.

LCAAP, originally called Lake City Arsenal, has been in continuous operation since 1941, except for a 5-year period between World War II and the Korean War. The plant was originally established as a government-owned, contractor-operated military installation to produce small caliber ammunition. The plant has been modified since World War II to produce larger ammunition. LCAAP is under the jurisdiction of the U.S. Army Industrial Operations Command. The operating contractor from 1941 to 1985 was Remington Arms. In November 1985, the plant operation was assumed by Olin Corporation (Burns and McDonnell 1999). The current operating contractor at LCAAP is Alliant Techsystems, which assumed operations from Olin Corporation in April 2000 (G. Anderson, Installation Restoration Program (IRP) Project Manager, personal communication, February 8, 2001).

LCAAP is the largest producer of rifle and machine gun ammunition for the U.S. Army. Support areas for the plant include an environmental laboratory, wastewater treatment plant EXIT, firing ranges, a calibration laboratory, machine shop, pipe fitting shop, electric shop, and a wood shop (USACHPPM 1998). Access to LCAAP is restricted by an outer fence surrounding the entire plant and an inner fence surrounding the main industrial area, which includes the high explosives manufacturing areas. Army Reserve and National Guard training exercises have also taken place on site since the 1960s. Most training exercises are conducted at the firing ranges in the eastern section of the plant, located southwest of Veteran's Lake. The firing range is fenced and only authorized personnel are allowed access.

Chemicals that are used on site in the plant's production process include soaps, detergents, bleaches, hydrochloric acid, sulfuric acid, nitric acid, explosive compounds (e.g., lead azide and lead styphnate), phosphate cleaners, petroleum and lubricating oils, and trichloroethylene (TCE) and other cleaning solvents. Previous wastewater treatment and solid waste disposal practices at LCAAP relied on burn pits, unlined lagoons, and landfills. Past waste disposal practices resulted in contamination of soil, groundwater, and some surface water bodies at the plant. Current waste management includes treatment through a permitted industrial wastewater treatment plant (IWTP) and disposal to an off-site Resource Conservation and Recovery Act permitted waste disposal facility (EA Engineering 1994).

In 1980, an installation assessment (IA) of LCAAP was conducted to assess the environmental quality of the plant with regard to use, storage, treatment, and disposal of hazardous substances, and to identify potential public health hazards (USACHPPM 1998). The IA included a preliminary investigation of all past waste disposal sites and chemical releases and focused on seven areas within the plant which had previously been used for industrial waste storage, including landfills, chemical laboratories, and an IWTP. Initial sampling indicated the presence of explosives, metals, volatile organic compounds (VOCs), and related breakdown products in soil and groundwater (Plexus Scientific Corp. 1996).

In 1985, the United States Army Toxic and Hazardous Materials Agency, as part of the Department of Defense's Installation Restoration Program, conducted a preliminary assessment/site investigation (PA/SI) at LCAAP. The PA/SI involved the installation of 24 groundwater monitoring wells and the analysis of 48 soil and water samples. All groundwater sample locations contained VOCs, semivolatile organic chemicals (SVOCs), explosives, and metals. As a result of finding silver in groundwater samples collected from Area 3 that exceeded the U.S. Environmental Protection Agency's (EPA) drinking water maximum contaminant levels, EPA placed LCAAP on the National Priorities List of hazardous waste sites in 1987 (EA Engineering 1989; USACHPPM 1998). In August 1987,

LCAAP implemented a potable well sampling program which included monitoring of some off-site private drinking water wells (USATHAMA 1990).

Following the PA/SI, LCAAP was divided into 33 study areas. These areas are currently grouped into three operable units (OUs): the Area 18 OU, the Northeast Corner OU (Areas 11, 16, and 17), and the Installation-Wide OU, which includes all other study areas. The remedial investigation has been completed for the Area 18 OU and is still in progress for the Northeast Corner OU and for the Installation-Wide OU. A record of decision (ROD) has been completed for the Area 18 OU and a ROD for Interim Remedial Action has been completed for the Northeast Corner OU. An Interim Remedial Action ROD for metals contaminated soil for the Installation-Wide OU is scheduled to be signed in the Fall 2001. LCAAP is still working on developing a schedule for releasing a final ROD for the Installation-Wide OU. A more detailed description of each of the 33 study areas (Figure 2) and their corresponding OUs is included in Table 2.

ATSDR Involvement

The Agency for Toxic Substances and Disease Registry (ATSDR) released a Preliminary Health Assessment for LCAAP in January 1989. Based on limited available information at that time, ATSDR considered LCAAP to be of potential public health concern because of the risk to human health from exposure to contaminants through groundwater, soil, and surface water pathways. As part of the public health assessment process, ATSDR conducted a site visit and met with representatives from LCAAP in April 1999. During the site visit, ATSDR viewed the areas of contamination and gathered information. At the time, ATSDR did not identify any completed exposure pathways requiring immediate action. In July, 2001, ATSDR participated in a public availability session (PAS) at LCAAP. ATSDR extended the public comment period until July 26, 2001 for the PHA so that community members would have an opportunity to provide any additional comments or concerns at the PAS.

Demographics

ATSDR examines demographic information, or population information, to identify the presence of sensitive populations, such as young children and the elderly, in the vicinity of a site. Demographics also provide details on residential history in a particular area, information that helps ATSDR assess time frames of potential human exposure to contaminants. Demographic information for the site and residential areas surrounding LCAAP is presented in this section.

Peak employment at the plant occurred during World War II, with over 20,000 employees.Since then, the number of people employed at LCAAP has diminished considerably. As of April 2000, LCAAP employs approximately 700 people, nearly all are civilians (Plexus Scientific Corp. 1996). There are 11 dwellings located in the southwestern portion of the plant reserved for military personnel. There are currently 51 residents living in this housing area and approximately 29 of these individuals are under the age of 18. This small housing area is on a hill and is separated from the main part of the plant by natural vegetation. An inner fence also separates the housing area from the high explosive production area in the south central part of the plant. Although a small number of children reside in the housing area, there are no day care centers or schools located at the plant.

According to 1997 census estimates, the population of Jackson County, where LCAAP is located, is approximately 648,000. According to the 1990 U.S. Census, however, there are less than 65 people who live within a one mile radius of LCAAP. Two small residential communities, Lake City, to the north (population less than 25 with 10 occupied dwellings), and Buckner, to the northeast (population of approximately 3,000) are located near LCAAP.

Land Use and Natural Resources

LCAAP is entirely fenced and access is controlled by a guarded gate at the main entrance. Other gates around the plant are generally not open unless supervised by official personnel. The plant contains 461 buildings and the industrial area occupies approximately 700 acres of flat land located in the central portion of the plant (USACHPPM 1998).

LCAAP lies within the Osage Plains Section of the Central Lowlands Physiographic Province. This area is characterized as a plain of low relief with broad stream valleys and flood plains of the Missouri River. It is underlain by nearly flat-lying, late Paleozoic sedimentary strata (EA Engineering 1994). The north and west portions of the plant are relatively flat areas whereas the south and east portions of the plant form uplands which have narrow crested ridges and 150 to 160 feet of relief from valley floor to ridge top.

Approximately 520 acres in the northeastern part of LCAAP are maintained as an outdoor recreation area. Veteran's Lake, covering 17 acres, is located within the recreation area and is used for fishing, hunting in specified areas, and mushroom harvesting. Efforts have been made to stock catfish in Veteran's Lake. There are also many ponds scattered throughout the plant, some of which may be used for fishing. Deer and wild turkeys are two common species of wildlife that are found on the plant's grounds. During the hunting season, the number of hunting permits is regulated and hunting is only allowed during normal non-operating hours of the plant, such as weekends and holidays. The recreation area is not located near any areas of contamination, however, because the area is located within the overshoot of the ballistics firing range, camping is not permitted (USACHPPM 1998).

Quality Assurance and Quality Control

In preparing this PHA, ATSDR reviewed and evaluated information provided in the referenced documents. Documents prepared for the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA) programs must meet specific standards for adequate quality assurance and control measures for chain-of-custody procedures, laboratory procedures, and data reporting. The environmental data presented in this PHA are from site characterization, remedial investigation, and groundwater monitoring reports prepared by the United States Army under CERCLA and RCRA. The validity of the analyses and conclusions drawn in this document are dependent on the availability and reliability of the referenced information. ATSDR reviews data from site-related reports and evaluates whether detection limits are set at levels that are protective of public health. ATSDR also notes any inconsistencies or problems with data collection or reporting and evaluates whether the information is adequate to be used for making public health decisions. Based on our evaluation, ATSDR determined that the quality of environmental data available for most site-related documents for LCAAP is adequate to make public health decisions.

EVALUATION OF POTENTIAL EXPOSURE PATHWAYS

Introduction

In this section, ATSDR evaluates whether community members have been (past), are (current), or could be (future) exposed to harmful levels of chemicals. ATSDR's exposure evaluation process is presented in Figure 3. As the figure indicates, ATSDR considers how people might come into contact with, or be exposed to, contaminated media. Specifically, ATSDR determines whether an exposure could occur through ingestion, dermal (skin) contact with contaminated media, or inhalation of vapors, and also considers the likely length (duration) and frequency of the exposure.

If exposure was or is possible, ATSDR then considers whether chemicals were or are present at levels that might be harmful to people. ATSDR does this by screening the concentrations of contaminants in an environmental medium (e.g., soil, water, air) against health-based comparison values (CVs). CVs are chemical concentrations that health scientists have determined are *not likely* to cause adverse effects, even when assuming very conservative/safe exposure scenarios. Because CVs are not thresholds of toxicity, environmental levels that exceed CVs would not necessarily produce adverse health effects. If a chemical is found in the environment at levels exceeding its corresponding CV, ATSDR examines potential exposure variables and the toxicology of the contaminant. ATSDR emphasizes that regardless of the level of contamination, *a public health hazard exists only if people come in contact with, or are otherwise exposed to, harmful levels of contaminated media.*

Environmental data for potential exposure pathways have been reviewed by ATSDR. Following the strategy outlined above, ATSDR examined whether human exposure to harmful levels of contaminants via these pathways existed in the past, exists currently, or could potentially exist in the future. ATSDR summarizes its evaluation of these exposure pathways in Table 3 and describes it in more detail in the discussion that follows. To acquaint readers with terminology used in this report, a list of CVs and a glossary are included in Appendices A and B, respectively.

Evaluation of Groundwater Exposure Pathway

Conclusion

- *ATSDR concludes that past exposures to groundwater at LCAAP* ***pose no public health hazard****. In the past, drinking water for LCAAP has been supplied by 14 on-site production wells. VOCs have been detected in some of the plant's drinking water supply wells, however, they did not occur at levels that would cause adverse health effects. Because some exposure was possible, ATSDR has categorized past exposures to groundwater at LCAAP as a "No Apparent Public Health Hazard."*

- *Exposure to on-site groundwater* ***poses no current or future public health hazard*** *at LCAAP. With the exception of on-site housing units, which are connected to the city of Independence municipal water system, drinking water for LCAAP is currently supplied by 13 on-site supply wells, eight of which are currently connected to air strippers that are designed to remove VOCs. One former supply well is now used as a water extraction and recovery well. Recent drinking water monitoring test results meet state and federal safe drinking water standards.*

- *Groundwater plumes located in the Area 18 OU and the Northeast Corner OU are very close to the plant's fence line and some low levels of VOCs, explosives, and metals have been detected in private wells to the north of the Area 18 OU and the Northeast Corner OU. Results of routine groundwater monitoring of northern perimeter wells and off base wells north of LCAAP during 1998 and 1999 did not indicate the presence of VOCs at levels of health concern. The nature and extent of groundwater contamination north of LCAAP should be further characterized in order to evaluate the potential for the groundwater plumes to migrate off site. Currently, a groundwater extraction system pumps groundwater from underneath LCAAP and is designed to*

contain contaminated plumes on site. Construction of a permeable reactive wall (PRW) was completed in Fall 2000 in the Northeast Corner OU. The PRW is designed to filter VOC contaminants as groundwater passes through the permeable wall. Based on monitoring well data and remedial activities at LCAAP, ATSDR concludes that off-site drinking water wells ***pose no past, current, or future public health hazards.*** *Because any potential exposure that might occur would be to levels of contaminant not expected to present a public health hazard, ATSDR has categorized past, current, and future exposures from off-site drinking water wells as a "No Apparent Public Health Hazard."*

Discussion

Physical Characteristics and Hydrogeology

Generally, LCAAP groundwater flows to the north and northwest. However, a groundwater flow divide exists in the central portion of LCAAP as a result of pumping of groundwater from production wells. During groundwater investigations at LCAAP, a model was developed to help conceptualize how groundwater flows underneath LCAAP. The model identifies three hydrostratigraphic units (HUs) (HU1, HU2, and HU3) (EA Engineering 1994):

- HU1-- This unit extends from the ground surface to a depth of approximately 20 to 40 feet below the ground surface (bgs) and is comprised of a silty clay and fine sand.

- HU2 -- This unit is approximately 40 to 50 feet thick and is present from 20 to 40 feet bgs to a maximum depth of 80 to 90 feet bgs. It is comprised of fine to coarse sand and fine to coarse gravel with a variable silt content. This unit has a very good ability to transmit water and is the primary aquifer in the area. HU2, often referred to as the Lake City Aquifer, provides nearly 1.2 million gallons of water per day to the plant.

- HU3 -- This unit exists below a depth of 90 feet bgs and is made up of shale and limestone from the bedrock underlying the residual soil in the uplands and the sediment in the valley. This unit has a poor ability to transmit water (EA Engineering 1994).

HU1, the shallowest unit, covers most of the plant. The horizontal hydraulic gradients in HU1 are strongly influenced by both topography and the surface water drainage ditches. These ditches were constructed in areas of natural drainage depressions in order to control flooding. HU1 is also affected by the withdrawal of groundwater from the deeper HU2 aquifer (EA Engineering 1998a).

A large portion of LCAAP, primarily the western and northeastern portion, is situated in a valley where the water table is very shallow. The far west and southwestern portion of the plant consists primarily of uplands. The valley consists of HU1, HU2, and HU3, whereas the uplands generally only contain HU1 and HU3. The major difference between the two areas is that the groundwater flow in the uplands is strongly influenced by topography and the flow in the valley is primarily controlled by pumping of the water supply and recovery wells (Dames & Moore 1999).

Groundwater Use

The plant's potable and industrial water needs are provided by a series of 22 production wells. LCAAP currently obtains its drinking water from 13 active on-site supply wells. All drinking water supplied by on-site production wells is screened in the HU2 aquifer at approximately 90 feet bgs. Eight of the 13 water supply wells are currently connected to five air strippers that remove most of the VOCs prior to distribution (Dames & Moore 1999; F.J. Abshier, Olin Corporation, Winchester Division, personal communication, October 26, 1999). The air strippers were installed between 1988 and 1990. After the raw water is processed through the air strippers, groundwater is pumped through an aerator to a clarifier, where lime (to achieve optimal pH for water softening) and alum (a coagulant) are added. The water then flows through sand filters for removal of suspended solids. The water is chlorinated and the finished water from all 13 supply wells is collected in a 500,000 gallon holding tank where the water is blended prior to distribution (USACHPPM 1998)(W. Melton, Environmental Engineer, LCAAP, personal communication, 1999). According to plant officials, the on-site housing units have been connected to the city of Independence municipal water supply for over 4 years (G. Kelso, Environmental Engineer, LCAAP, personal communication, June 29, 1999).

The communities surrounding LCAAP rely mostly on groundwater for their drinking water supply. The residents living near LCAAP are supplied with municipal water primarily from one of three sources: 1) Jackson County residents living to the west, northwest, and southwest (Independence), south (Blue Springs), north (Lake City), and northeast (Buckner) of LCAAP obtain drinking water mostly from the city of Independence water department, which obtains water almost entirely from groundwater supplies; 2) some residents living north and northeast of LCAAP obtain their water from the Kansas City Water Services, which uses about half groundwater and half surface water from the Missouri River about 8 miles to the north of LCAAP; and 3) a small number of residents living southeast and east of LCAAP get municipal water from the Jackson County public water supply, which purchases most of its water from the Kansas City Water Services or the city of Independence water department (MDNR 1999). A small number of residences north of LCAAP also rely on private wells for their drinking water. Most of the private wells to the north of the plant draw water from the Lake City Aquifer.

Nature and Extent of Groundwater Contamination

On-Site Groundwater Contamination

Results of 1999 quarterly and annual monitoring of drinking water from LCAAP's water supply plant (treated water prior to distribution) showed that vinyl chloride (0.9 parts per billion [ppb]) slightly exceeded ATSDR's health-based CV of 0.7 ppb. Four other chemicals exceeding CVs, bromodichloromethane (BDCM) (6.2 ppb), bromoform (5.0 ppb), bromomethane (69.6 ppb), and dibromochloromethane (CDBM) (9.3 ppb), were present in the finished water (Continental 1999a; 1999b). BDCM, bromoform, bromomethane, and CDBM are not chemicals associated with the routine operations at LCAAP. These chemicals are common by-products of chlorination. Chlorine is added to drinking water to kill disease-causing organisms (ATSDR 1989, 1990, 1992).

TCE and other VOCs have been detected in several of the plant's 13 drinking water supply wells prior to being processed by air strippers. During 1998-1999, TCE (34 ppb) was detected in supply well 17-AA (located within Area 12) above its CV. One sample at supply well 17-K (Area 22) and three samples at supply well 17-P (Area 14) contained vinyl chloride (8 ppb) above its CV. One sample collected in November 1998, at supply well 17-JJ (located near the center of the plant), contained tetrachloroethylene (PCE) (1.7 ppb), slightly above its CV (Dames & Moore 1999; Dames & Moore 2000).

Results of samples collected from 1990 to 1997 indicate that three of the 13 active water supply wells (17-AA, 17-K, and 17-P) contained levels of contaminants above CVs. TCE (52 ppb) was detected above its CV in well 17-AA and the levels appeared to be relatively stable from 1990 through 1997. Water from this supply well was not drawn from extensively in the past because of its high mineral content (F.J. Abshier, Olin Corporation, Winchester Division, personal communication, October 26, 1999). Vinyl chloride (8 ppb) was detected above its CV in wells 17-K and 17-P. Vinyl chloride was detected only once in well 17-K (Dames & Moore 1999). One supply well (17-FF) was converted to a water extraction and recovery well in 1998 and is currently being used to remove VOCs. Samples collected from this well, prior to its conversion, contained 1,2-dichloroethylene (1,2-DCE) (380 ppb) and vinyl chloride (270 ppb) (Dames & Moore 1999).

LCAAP routinely samples and analyzes groundwater from about 150 monitoring wells across the plant. However, as many as 222 wells (including production wells and off-site wells) have been sampled as part of past environmental investigations (EA Engineering 1994). VOCs, SVOCs, explosives, metals, and some radionuclides were detected in groundwater in several areas of the plant. Some VOCs were detected in groundwater at levels above CVs. Groundwater sampling in the Northeast Corner OU (Areas 16 and 17) and in the Area 18 OU have identified VOC plumes that extend to the northern perimeter of the plant. The nature and extent of contamination beyond the northern plant boundary has not been fully characterized and it is possible that some groundwater contamination has migrated off site. Other VOC plumes have been identified in areas near the west and northwest portion of the plant, in Areas 7 and 12, and in Area 8 in the southwestern portion of the plant, which are part of the Installation-Wide OU. Sampling results reported in 1994 identified 1,2-DCE as the most common chlorinated compound detected in the groundwater at LCAAP (EA Engineering 1992).

At the Northeast Corner OU, 1,2-DCE was detected at concentrations as high as 300,000 ppb in the immediate vicinity of the solvent pits and as high as 1,000 ppb within 400 feet downgradient of the solvent pits. Two VOCs, TCE (87 ppb) and PCE (8.1 ppb), and two metals, lead (26 ppb) and cadmium (21 ppb), were detected above their CVs in the HU2 aquifer in the Northeast Corner OU (EA Engineering 1995a, 1998a).

Samples collected from the Area 18 OU monitoring wells contained several VOCs, vinyl chloride (8,000 ppb), 1,2-DCE (4,000 ppb), TCE (68 ppb), benzene (42 ppb), 1,1-dichloro- ethylene (1,1-DCE) (35 ppb), and PCE (8.1 ppb), that exceeded their CVs. The highest VOC concentrations were found in the intermediate and deep monitoring well samples (50 - 90 feet deep) of HU2. In three of the shallow monitoring wells in HU2 (upper 30 feet), four VOCs, carbon tetrachloride (44 ppb), vinyl chloride (20 ppb), 1,1-DCE (15 ppb), and chloroform (8.8 ppb), were detected at levels above their CVs. Two metals, manganese (2,740 ppb) and arsenic (16.8 ppb), were also detected above their CVs (EA Engineering 1995b, 1998b).

Samples collected from the Installation-Wide OU monitoring wells contained VOCs and other contaminants, including metals, explosives, and some radiological activity. In Area 8, 1,2-DCE (93 ppb) and TCE (15 ppb) were detected above their CVs. Lead was detected above its CV at many sampling locations and the maximum concentration (4,900 ppb) was found in a shallow well in Area 2. This is likely due to the proximity of the well to an inactive wastewater treatment lagoon where high levels of lead in soil were detected. Cyclotrimethylene trinitramine (royal demolition explosive) (RDX) (1,200 ppb) and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (high melting explosive) (3,600 ppb) were the most prevalent explosives detected within the Installation-Wide OU above their CVs. Both alpha and beta radioactivity were detected above their CVs in Area 10 OU (firing range waste dump). The area is currently undergoing cleanup activities for depleted uranium which is being overseen by the Nuclear Regulatory Commission (USACHPPM 1998).

Off-Site Groundwater Contamination

LCAAP has installed eight off-site monitoring wells. The VOC plume associated with the Northeast Corner OU (Areas 16 and 17) has reached off-site monitoring wells to the north. These wells are connected to air strippers that remove VOCs. Three groundwater extraction wells located in the Area 18 OU pump water to an air stripper and help prevent VOCs from migrating beyond the plant

perimeter. Removing the groundwater creates a cone of depression underneath the plant and prevents most off-site migration (F.J. Abshier, Olin Corporation, Winchester Division, personal communication, October 26, 1999). The water is subsequently treated in the Area 18 OU pump and treat system prior to being discharged to the Little Blue Valley Sewer District (USACHPPM 1998; W. Hills , Division of Environmental Quality, Missouri Department of Natural Resources, personal communications, October 18, 1999).

Twelve residential wells were sampled by LCAAP as part of a quarterly monitoring program conducted from July 1988 through September 1993 (EA Engineering 1995b). Low levels of VOCs and explosives were occasionally detected during this monitoring period. In November 1989, 1,1-DCE (2 ppb), benzene (1.1 ppb), and TCE (3.1 ppb) were detected at levels slightly above their CVs; in January 1992, chloromethane (7.8 ppb) was detected in one well slightly above its CV; in December 1992, TCE (6.4 ppb) was detected above its CV in one well; in March 1993, two samples exceeded state and federal safe drinking water standards of 5 ppb (SDWS) for cadmium (8.9 ppb); and in September 1993, one sample slightly exceeded SDWS of 15 ppb for lead (15.9 ppb) (USACHPPM 1998; EA Engineering 1995b; Flatwater Group 2001). The source of the cadmium and lead in off site private wells is not known, however, cadmium (15 ppb) has been detected in monitoring wells (MW 99-5 and MW 99-6) near the northern boundary and lead and cadmium have been detected in soil at LCAAP; (EA Engineering 1994; Dames and Moore, 2000). In March 1998, six residential wells were sampled by the Missouri Department of Health. The results of these tests did not show any contaminants exceeding CVs (MDOH 1998).

Results of drinking water quality monitoring tests conducted in 1998 for the city of Independence water department and in 1999 for Kansas City Water Services Athierton water treatment plant did not identify any compounds that exceeded SDWS. These are the two primary drinking water suppliers for the areas around LCAAP. All municipal water departments in Jackson County routinely test their water supplies to ensure that they are in compliance with state and federal requirements (City of Independence Water Department 1998; Kansas City Water Services 1999).

Evaluation of Potential Public Health Hazards

Past Exposure

On-site - It is possible that prior to air strippers being installed at the plant, individuals may have consumed water from supply wells that contained levels of VOCs above ATSDR's health-based CVs. Past water sampling data have detected VOCs in excess of CVs in four water supply wells. Vinyl chloride has occasionally been detected at levels slightly above its CV in two supply wells (17-K and 17-P) and TCE has been consistently detected above its CV in one supply well (17-AA). Recovery well 17-FF was used as a supply well prior to 1998 and contained 1,2-DCE and vinyl chloride above their CVs.

When estimating the health significance of an exposure pathway, ATSDR estimates exposure doses and compares the values to standard health guidelines. In calculating human exposure doses, ATSDR made very conservative assumptions about the frequency and duration of exposure. ATSDR also assumed that LCAAP workers and on-site residents would be exposed to the maximum contaminant concentrations detected. These assumptions are often necessary because ATSDR does not know with certainty when contaminants first reached supply wells or how much contamination was present at the time water was being consumed from these wells. These assumptions likely overestimate actual exposure because workers are not likely to obtain most of their drinking water from LCAAP and the small number of individuals who have lived in the on-site housing area generally only reside there for a short period of time. Moreover, individuals at LCAAP are not likely to be exposed to these maximum concentrations because water from all supply wells is blended and stored in a large holding tank. The methods and assumptions used to estimate exposures and evaluate potential health effects are described in greater detail in Appendix C.

Since no individual well at LCAAP ever supplies all the drinking water for LCAAP and no one person drinks exclusively from one supply well at the maximum contaminant concentration, ATSDR concluded that past exposure to the LCAAP drinking water supply poses no public health hazard.

Off-site - Results of off-site groundwater monitoring tests and residential private well monitoring indicate that some VOCs, explosives, and metals, mostly at low levels, have migrated beyond the plant's perimeter in the north central portion of the plant, which includes the Area 18 OU and the Northeast Corner OU. A few contaminants, benzene, TCE, and 1,1-DCE, were detected at levels slightly above their CVs.

ATSDR evaluated exposures to private well water by off-site residents using the same conservative approach described above (see Appendix C). Based on this evaluation, ATSDR concluded that drinking water from these private wells does not pose a past health hazard because contaminant concentrations are too low to cause adverse health effects.

Current and Future Exposures

On-site - A system is in place to remove VOCs from the groundwater underneath the plant. LCAAP is a state permitted public drinking water supply and testing of treated water in conjunction with that permit is conducted on a monthly basis for VOCs and some metals. Although untreated groundwater in some areas underneath LCAAP has exceeded safe drinking water standards, recent water

monitoring results of the treated drinking water supply have met all state and federal drinking water standards. As long as LCAAPs drinking water treatment and monitoring program is in place, exposures to on-site drinking water from the supply wells at LCAAP pose no current or future public health hazards.

Off-site - Although low levels of some VOCs, explosives, and metals have been detected in private wells to the north of the Area 18 OU and the Northeast Corner OU between, these contaminants were mostly detected at levels below CVs. In 1992 eight groundwater monitoring wells were installed just off site to the north of the Area 18 and the Northeast Corner OU. According to data presented in the Annual Reports for LCAAP Comprehensive Groundwater Monitoring Program, these monitoring wells have not contained levels of VOCs that exceed EPA's maximum contaminant levels (Dames and Moore 2000). A permeable reactive wall (PRW) has been constructed in Area 16, which is designed to prevent further contamination of areas downgradient of the groundwater plume (G. Anderson, IRP Project Manager, LCAAP, personal communication, February 8, 2001). It is expected that the PRW and the groundwater extraction well, installed in 1998, at the northern boundary of the plant will prevent future off-site migration of contaminated plumes beneath LCAAP. Based on this information, it is unlikely that drinking water from these private wells will pose current or future public health hazards.

Evaluation of the Soil Exposure Pathway

Conclusion

> *Soil at LCAAP does not pose a past, current, or future public health hazard. Surface soil contamination, including VOCs, explosives, polycyclic aromatic hydrocarbons (PAHs), and metals, has been detected above ATSDR's health-based CVs in some areas of LCAAP. Access to most of these areas is restricted and any exposures by visitors or trespassers would likely be infrequent and of very short duration. LCAAP is in the process of out leasing part of the plant and, as a result, land use may change in the future. Surface soil contamination is being addressed by LCAAP through various interim remedial activities at each of the three OUs. These remedial activities should significantly reduce or eliminate the potential for harmful exposures to contaminants in the future.* According to LCAAP representatives, any proposed new land use at the Plant must be reviewed by LCAAP and the Operations Support Command. Any reuse of land must meet existing legal agreements and conditions, including land use restrictions and institutional controls in place at the time of the agreement. In addition, state (MNDNR) and federal (EPA) regulatory agencies are responsible for making sure that contaminated areas meet the applicable clean-up standards for the proposed land use. *The potential for exposures from surface and subsurface soil contamination should be reevaluated if out leasing at LCAAP ever results in unrestricted use of contaminated source areas.*

Discussion

Surface and subsurface soil samples were collected from most of the designated areas of concern on site. The primary soil contaminants, some of which exceed CVs for soil, are VOCs (e.g., TCE, PCE, vinyl chloride, and toluene), SVOCs, explosives (RDX is the most common explosive compound detected), and metals (e.g., arsenic, lead, and chromium). The nature and extent of soil contamination detected in each OU and corrective measures taken by LCAAP are summarized in the discussion that follows and in Table 2.

Nature and Extent of Soil Contamination

- *Northeast Corner OU*

  The Northeast Corner OU (Areas 11, 16, and 17) has a heavily contaminated oil and solvents pit; a 17-acre abandoned landfill; an area that received waste glass, paints, and solvents; and a contaminated burning ground. VOCs, SVOCs, metals, and explosives have been detected in both surface and subsurface soil, some above CVs. Most of the contaminants exceeding their CVs were found at the oil and solvents pit in Area 17. VOCs detected above CVs include TCE (2,000 ppm), PCE (420 ppm), 1,1,2-trichloroethane (62 ppm), and vinyl chloride (50 ppm). PAHs detected above CVs include benzo(a)pyrene (2,000 ppm), benzo(a)anthracene (3,000 ppm), benzo(b)fluoranthene (5,000 ppm), and benzo(k)fluoranthene (7,000 ppm). One metal, arsenic (50 ppm), was detected above its CV (EA Engineering 1998c).

  A ROD for Interim Remedial Action at the Northeast Corner OU addresses the primary source of soil contamination, the oil and solvents pits, located in Areas 16 and 17. The remedial action to be implemented involves installing a 24-inch thick vegetated soil cover over the Area 17B oil and solvent pits to minimize migration of contaminants to nearby soils. Institutional controls will also be implemented, including: 1) restriction of on-site worker's access to contaminated soil; 2) filing a notice to the deed detailing the restrictions of the continuing order to restrict on-site workers; and 3) a covenant to the deed in the event of a transfer of property (EA Engineering 1998a).

- *Area 18 OU*

  The Area 18 OU covers approximately 88 acres along the northern portion of the plant and consists of earth pits used for

disposal. VOCs detected above CVs include PCE (9,000 ppm) and TCE (1,000 ppm). The only metal detected above its CV was lead (1,600 ppm). The final ROD for remedial action at the Area 18 OU requires excavating and disposing of surface soils containing lead above cleanup levels (1,000 ppm) as long as the soil does not contain VOCs exceeding 10 ppb. The selected alternative in the ROD provided for on-site remediation of Surface soils containing both lead and VOCs exceeding 10 ppb with multi-phase vapor extraction (MPVE) beneath a two-foot soil cover (EA Engineering 1998b). However, based on data collected subsequent to the release of the Area 18 ROD, VOC contamination may be more widespread than previously expected. LCAAP has proposed revising the Area 18 ROD because the MPVE system may not be effective in addressing contamination in this area. LCAAP and regulators are considering the most appropriate corrective actions to be taken.

- *Installation-Wide OU*

  The Installation-Wide OU (consisting of 31 source areas) has a number of areas with surface and subsurface soil contamination. No VOCs were detected above CVs in surface soil. PAHs were detected in surface soils in Areas 22, 26, and 31. Total PAHs were detected in two surface soil samples in Area 31 above 15,000 ppm. The metals detected above CVs in surface soil at LCAAP include antimony (1,120 ppm, source: Area 13), lead (110,000 ppm, source: Area 2), copper (140,000 ppm, source: Area 7), and zinc (200,000 ppm, source: Area 7). VOCs were primarily detected in subsurface soil in Areas 3, 7, 14, and 30, including toluene, ethylbenzene, PCE, TCE, and 1,1,1-trichloroethane. However, only PCE (37 ppm) was detected in Area 7 above its CV (EA Engineering 1994). Explosives were also detected in soil, primarily subsurface soil, but none were above CVs (EA Engineering 1992).

Evaluation of Potential Public Health Hazards

Past Exposure

LCAAP is gated and access has always been restricted to the public. Most areas of contamination are located in isolated sections of the plant not frequently accessed by individuals on site. The housing area at the plant is on a hill surrounded by vegetation and is not in close proximity to any areas of contamination. There is an inner fence that separates the housing area from the explosives area. Children living in the housing area are restricted from going onto the plant. There have been occasional violations of these rules in the past by children living in housing on site, however, plant security have strictly enforced these rules. Access to the industrial areas of LCAAP is restricted by the inner fence and children would not ever have access to this area without being accompanied by an adult. For these reasons, exposure to contaminated soil did not pose a past public health hazard.

Current and Future Exposures

Soil remediation efforts at LCAAP include a proposed plan for interim remedial action for the Installation-wide OU which was released for public comment during the winter 2001 (LCAAP 2001). A final ROD for remedial action at the Area 18 OU and a ROD for interim remedial action at the Northeast Corner OU have been released. Soil remediation of waste pits and other areas of contamination will reduce the likelihood of any current or future exposures to individuals on site at LCAAP. Additional data collection and site evaluation may be required for some of the 31 designated areas within the Installation-wide OU to better characterize the nature and extent of contamination. LCAAP will not pose current or future health hazards to the public as long as access to the plant continues to be restricted and future land uses do not allow development of contaminated areas until they meet all state and federal cleanup guidelines.

Evaluation of Surface Water/Sediment Exposure Pathway

Conclusion

Surface water and sediment at LCAAP do not pose a past, current, or future public health hazard. Contaminant levels were generally below CVs for surface water and sediment samples across LCAAP. A few contaminants were detected in close proximity to source areas above CVs. However, most water-related recreational activities on site take place on or near Veteran's Lake which is not very close to any areas of contamination.

Discussion

Surface Water Use

LCAAP is located on a surface water divide. Surface water drainage originating from the western portion of the plant flows northwest toward West Fire Prairie Creek and eventually Little Blue River, less than 1 mile away. Drainage originating from the eastern portion of the plant flows northeast toward East Fire Prairie Creek and eventually into the Missouri River, approximately 5 miles away (EA Engineering 1994). There are four locations occupying a total of 5.58 acres at LCAAP that have been designated as wetland areas by theU.S. Army Corps of Engineers.

Surface water is not used as a source of drinking water for LCAAP or for most of the residential, commercial, and industrial areas located near the plant. The only surface water source of drinking water in the area is from the Missouri River located approximately 8

miles north of LCAAP (R. Maley, Missouri Department of Health, personal communication, October 19, 1999). Veteran's Lake is located in the northeast portion of the plant and is used for recreational activities such as boating and fishing. Swimming is not permitted at Veteran's Lake. There are a number of small ponds scattered across the plant, some of which are used for fishing.

Nature and Extent of Surface Water/Sediment Contamination

Metals, some explosives (e.g., RDX), and a few VOCs were detected above their CVs in some of the surface water and sediment sampled in the areas of contamination. Most of the surface water and sediment samples taken were in close proximity to sources of contamination. VOCs detected in surface water above their CVs include TCE (21 ppb), chloroethane (90 ppb), bromodichloro-methane (5.22 ppb), and dibromochloromethane (3.38 ppb). Since access to the plant is restricted, exposure to sediment is unlikely for individuals located off site. Remedial activities are ongoing at LCAAP, thereby reducing the potential for individuals to be exposed to site-related contaminants in the future.

Veteran's Lake was eliminated from further consideration as a source of contamination in the RI report of the Installation-Wide OU released in 1994 because all compounds detected in surface water were comparable to background levels (EA Engineering 1994). In 1992, 1,2-DCE (27 ppb) and TCE (21 ppb) were detected in a surface water sample taken from Ditch B, in the Area 18 OU. Surface water from Ditch B eventually flows off site to the northeast toward East Fire Prairie Creek. In 1992, surface water and sediment samples were taken from three off-site locations, one of which was downstream of Ditch B. These samples did not contain concentrations of metals, explosives, or VOCs that exceeded CVs (EA Engineering 1994).

Evaluation of Potential Public Health hazards

Past Exposure

Most of the contaminants detected in surface water and sediment across LCAAP were below CVs. On-site surface water is not used as a source of drinking water for LCAAP and any potential exposures to on-site surface water and sediment would have been infrequent and of short duration. Most fishing and recreational activities at LCAAP are limited to Veteran's Lake. The closest area of contamination is over one-half mile to the northwest of this lake and the concentrations found are too low to pose a health hazard. ATSDR concludes that past exposures to surface water and sediment did not pose a public health hazard.

Current and Future Exposures

Since most of the contaminants detected in surface water and sediment were below their CVs and remedial activities are ongoing at LCAAP, it is unlikely that individuals are currently being exposed or will be exposed in the future to site-related contaminants at harmful levels. Some VOCs were found in surface water samples taken from Ditch B in the Area 18 OU. There is the potential for surface water to runoff into East Fire Prairie Creek located northeast of the Area 18 OU; however, it is not likely that contaminant levels would be found at harmful levels. ATSDR concludes that current and future exposures to surface water and sediment do not pose a public health hazard.

Evaluation of Air Exposure Pathway

Conclusion

No public health hazards are associated with past air exposures in and around LCAAP. Because exposure was possible, ATSDR has categorized this site as a"No Apparent Public Health Hazard". No current or future public health hazards are associated with exposure to air contaminants at LCAAP. Exposures to VOCs and other air pollutants may have occurred in the past, however, there are no data to evaluate whether contaminants released into air were present at levels that were harmful. Most VOCs were released near the center of the plant, within the main industrial area, and it is unlikely that ambient air concentrations would have been high enough to pose a health hazard to residents living at the housing area on site or at off-site locations near LCAAP. Open burning/open detonation of explosive materials were conducted prior to 1993. According to LCAAP officials, approximately 300 pounds of explosives materials were burned per week, which was substantially below the permitted amount of 1,440 pounds. LCAAP also minimized potential exposure to air contaminants off site by only conducting burns if certain whether conditions were met. VOC emissions from the sealing operations units are currently being controlled through source reduction measures, and the explosives waste incinerator (EWI) contains an air pollution control system.

Discussion

Nature and Extent of Air Contamination

The principle sources of air emissions at LCAAP are the sealing operations units and the EWI (USACHPPM 1998). In addition, annual burning permits were previously issued to LCAAP for open burning of wet pyrotechnics and propellant powder, open detonation of explosives, and explosives demonstrations and testing. These operations ceased in April 1993 when the last open burning permit expired.

Historically, the sealing operations units, located in the central industrial area, have released some VOCs and other ozone depleting chemicals (e.g., ethyl acetate, methyl chloroform, ethyl alcohol, methyl ethylketone, and toluene). Several provisions to reduce ozone depleting chemicals and VOC emissions have been implemented at LCAAP. For example, water-based paint has been substituted for lacquer-based paint and biofilters have recently been installed to reduce VOC emissions at the plant (USACHPPM 1998; P. Anthamattenn, LCAAP, Personal correspondence, March 1, 2001).

LCAAP operated the burning ground area for the open burning/open detonation of waste explosives, mixes, and powders. Burning activities, which took place from the middle 1950's until April 1993, were generally conducted once a week as long as specific weather conditions were met. According to LCAAP officials, the weather conditions required for open burning were mostly clear skies, winds less than 10 knots, and temperatures greater than 35 degrees. Open burning only took place between 9:00 am and 4:00 pm (P. Anthamatten, LCAAP, Personal coorrespondence, March 22, 2001).

Based on historical information, approximately 300 pounds of materials per week were burned at LCAAP. The most common materials burned were propellant and wet explosive scrap (e.g., calcium resinate, magnesium, barium peroxide, polyvinyl chloride, and propellant powder). The permitted burn rate for these wastes could not exceed 240 pounds per day, every day for a maximum of 1,440 pounds per week. Based on historical information, LCAAP was well under the permitted rates averaging about 60 pounds per day (P. Anthamattenn, LCAAP, Personal correspondence, March 1, 2001).

The EWI is located near the center of the plant in Area 7. The incinerator contains an air pollution control system which removes particulate and hazardous organic waste constituents from exhaust gases and collects small particles in the baghouse. Cleaned exhaust is discharged into the atmosphere through a 30-foot exhaust stack (USACHPPM 1998; U.S. Army Environmental Hygiene Agency 1991). The stack is monitored routinely for carbon monoxide and nitrous oxide.

Evaluation of Potential Public Health Hazards

Past Exposure

Some past activities at LCAAP may have resulted in the release of air contaminants near the source. Since air monitoring data from past operations at LCAAP are not available, ATSDR cannot determine whether exposures to levels of air contaminants above ATSDR's CVs occurred in the past. Most VOCs were released near the center of the plant, within the main industrial area, and it is unlikely that ambient air concentrations would have been high enough to pose a health hazard to residents living at the housing area on site or at off-site locations near LCAAP. According to correspondence from LCAAP officials, no unusual open burn/open detonation events or incidents took place and ATSDR is not aware of any complaints from residents living near LCAAP during the time period that open burning/open detonation occurred. For these reasons, ATSDR concludes that air contaminants in and around LCAAP pose no public health hazard for past exposures.

Current and Future Exposures

Current and future exposures to harmful levels of air contaminants are not expected because activities such as burning of explosives have been discontinued and sealing operations have been modified to reduce contaminant emissions. The EWI is not a significant source of air pollution at the plant because of its air pollution control system.

COMMUNITY HEALTH CONCERNS

In order to identify the concerns of local residents, community interviews were conducted by representatives of the United States Army Environmental Center, LCAAP, and Plexus Scientific Corporation in June 1995. Interviews were conducted with citizens living near the plant, as well as community business and political leaders (Plexus Scientific Corp. 1996). The following health concern was expressed by residents:

- *Concern about groundwater contamination in private drinking water supplies.*

Environmental investigations have identified areas of groundwater contamination at LCAAP. Most of the groundwater plumes are contained on site and are not expected to migrate beyond the plant's boundary. The Area 18 OU in the north central part of the plant and the Northeast Corner OU contain groundwater plumes that may extend beyond the plant perimeter. Some private wells to the north of LCAAP have been monitored. A couple of the wells sampled did contain levels of contaminants that were slightly above ATSDR's health-based CVs (See Evaluation of Groundwater Pathway Section and Appendix C). However, the samples collected did not contain harmful levels of contaminants and the water does not pose a public health hazard.

- *Concern about allergies and other health effects (e.g., dizziness) resulting from pollution released from LCAAP.*

As stated previously, some past activities at LCAAP may have resulted in the release of air contaminants near the source. However,

according to LCAAP officials, these releases have not exceeded amounts permitted by the state of Missouri. Additionally, most air contaminant releases at LCAAP are from the industrial area located near the center of the plant. Any pollutants migrating off site would be diluted and would not be expected to cause allergies or pose a health hazard.

ATSDR CHILD HEALTH INITIATIVE

ATSDR recognizes that infants and children may be more sensitive than adults to environmental exposure in communities faced with contamination of their water, soil, air, or food. This sensitivity is a result of the following factors: (1) children are more likely to be exposed to certain media like soil when they play outdoors; (2) children are shorter and therefore may be more likely to breathe dust, soil, and vapors close to the ground; and (3) children are smaller than adults and therefore may receive a higher dose of chemical exposure relative to their body weight. Children also can sustain permanent damage if exposed to toxic substances during critical growth stages. ATSDR is committed to evaluating children's special interests at sites such as LCAAP as part of its Child Health Initiative. **ATSDR identified no situations in which children are likely to be exposed to harmful levels of chemical contaminants associated with LCAAP.**

ATSDR evaluated the likelihood that children living at or near LCAAP may have been or may be exposed to contaminants at levels of health concern. The number of children living at the LCAAP housing area is very small. The exact number is quite variable, but currently there are 23 children under the age of 18 living at the LCAAP housing area. ATSDR determined that harmful exposures are unlikely to occur because children living at this housing area do not have access to the main plant where areas of contamination are located. There are no day care centers or schools located on site and none are expected in the future. According to LCAAP officials, the housing area has been connected to the city of Independence water supply for approximately 4 years (G. Kelso, Environmental Engineer, LCAAP, personal communication, June 29, 1999). The primary recreational area at LCAAP, Veteran's Lake, is located at least one-half mile from any areas of contamination and it is unlikely that children who visit this recreational area would be exposed to harmful levels of contaminants. ATSDR did not identify any situations at LCAAP where children were likely to have been exposed to contaminants at levels which pose a health concern.

CONCLUSIONS

After evaluating available environmental information, ATSDR has drawn the following conclusions regarding media- and site-specific exposures:

- *Exposure to on-site groundwater at LCAAP in the past poses no public health hazard.* LCAAP, including the on-site housing area, has obtained drinking water in the past from 14 on-site supply wells. VOCs have been detected in some of these supply wells above CVs. ATSDR evaluated these potential exposures and determined that these contaminants were not in the LCAAP water supply at levels associated with adverse health effects. Because some exposure was possible, ATSDR has categorized past on-site groundwater exposure as a "No Apparent Public Health Hazard."

- *Exposure to on-site groundwater at LCAAP poses no current or future public health hazard.* Air strippers have been installed to remove VOCs from the groundwater. The water from 13 on-site supply wells is blended and stored in a 500,000 gallon holding tank. Recent monitoring tests going back to 1990 do not show contaminants exceeding their CVs in most of the supply wells. On-site drinking water at LCAAP meets state and federal drinking water standards. The 11 on-site housing units are connected to the city of Independence water supply.

- *Exposure to off-site groundwater poses no past, current, or future public health hazard.* Some off-site private wells located to the north of the Area 18 OU and the Northeast Corner OU contained VOCs that were mostly below ATSDR's health-based CVs. VOCs that were detected above CVs in the private drinking water wells were not found at levels that are associated with adverse health effects. A groundwater extraction well is currently operating to contain the contaminated plume on site. Because some exposure was possible, ATSDR has categorized off-site exposure from private wells as a "No Apparent Public Health Hazard." ATSDR will revisit the site if new information or data becomes available.

- *Exposure to soil contamination at LCAAP poses no past, current or future public health hazard.* Access to the plant is restricted and any contact with contaminated soil by visitors at the plant would likely be of short duration and would not result in harmful levels of exposure. In addition, ongoing remedial activities at LCAAP, will further reduce the potential for individuals to be exposed to site-related contaminants in the future. However, future plans of LCAAP may include outleasing parts of the land for

private use. ATSDR may need to reevaluate this exposure pathway if new site-related activities include more frequent contact with contaminated soil.

- *Exposure to surface water and sediment at LCAAP poses no past, current, or future public health hazard.* Most of the contaminants detected in surface water and sediment were below CVs and surface water is not a source of drinking water at LCAAP. In addition, ongoing remedial activities at LCAAP, will further reduce the potential for individuals to be exposed to site-related contaminants in the future. It is unlikely, therefore, that individuals were exposed in the past, are currently being exposed, or will be exposed in the future to surface water contaminants at harmful levels.

- *Air contaminants in and around LCAAP pose no public health hazard for past exposures.* Although no monitoring data are available, most VOCs and other air pollutants were released near the center of the plant within the main industrial area. It is unlikely that ambient air concentrations would have been high enough to pose a health hazard to residents living at the housing area on site or at off-site locations near LCAAP. Because some exposure was possible, ATSDR has categorized past exposures from air contaminants as a "No Apparent Public Health Hazard."

- *Exposure to air contaminants at LCAAP poses no current or future public health hazard.* Current and future exposures to harmful levels of air contaminants are unlikely because activities such as burning of explosives have been discontinued and sealing operations, which generated VOCs and other air pollutants, have been modified to reduce contaminant emissions.

- ATSDR considers the groundwater, on-site soil, surface water and sediment, and air exposure pathways associated with LCAAP to pose *no public health hazards.*

PUBLIC HEALTH ACTION PLAN

The public health action plan (PHAP) for LCAAP contains a description of actions to be taken by ATSDR and/or other government agencies at and in the vicinity of the site upon completion of this public health assessment. The purpose of the PHAP is to ensure that this public health assessment not only identifies public health hazards, but provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The plan includes a commitment on the part of ATSDR to follow up and ensure that the plan is implemented. The public health actions completed and those to be implemented are as follows:

Actions Completed

1. LCAAP has completed a final ROD for interim remedial action at the Northeast Corner OU and a final ROD for remedial action at the Area 18 OU.

2. Eight water supply wells have been connected to five air strippers at LCAAP.

3. Private wells to the north of the Area 18 OU and Northeast Corner OU have been tested as part of a quarterly groundwater monitoring program.

Actions Ongoing or Planned

1. ATSDR supports continuing routine (quarterly and annual) testing of the plant's drinking water supply wells for groundwater contaminants associated with LCAAP.

2. A groundwater modeling effort is underway at LCAAP to characterize the extent of contamination and whether contaminated plumes are migrating off site. This will help provide future recommendations for operation of the plant's water supply.

3. Soil remediation efforts are ongoing and final RODs have been or will be released to address other remedial actions (e.g., surface water, sediment, institutional controls) for each of the OUs.

4. Some of the areas of contamination have interim control measures or land-use restrictions (e.g., prohibiting agriculture or grazing). ATSDR supports these remedial measures and recommends frequent monitoring of these activities to ensure they are in place for the period of time required by the RODs.

5. A groundwater extraction and recovery system is operating in the Area 18 OU and is designed to contain the contaminated groundwater plume on site. ATSDR recommends continued routine monitoring of off-site groundwater contamination, downgradient of the Area 18 extraction system. In addition, new monitoring wells should be installed off site in any locations where data gaps may be occurring.

Recommendations

1. As a precautionary measure, ATSDR recommends resuming routine monitoring of off-site private wells to the north of the Area 18 OU and Northeast Corner OU.

2. ATSDR recommends that LCAAP conduct routine (e.g., annual) surface water and sediment sampling of East Fire Prairie Creek and any other surface waters that flow off site to ensure that contaminants from ditches and drainage canals in the Area 18 OU and the Northeast Corner OU are not entering the creek via surface water runoff.

3. ATSDR recommends that any area(s) of the plant that is/are leased undergo a final evaluation for environmental contamination to ensure that the area does not pose a public health hazard.

4. ATSDR recommends that Area 25 (the Demolition Waste Dump) should be closely monitored by plant security to ensure that children from on-site housing do not gain access.

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PUBLIC HEALTH ASSESSMENT

LAKE CITY ARMY AMMUNITION PLANT
[(a/k/a LAKE CITY ARMY AMMUNITION PLANT (NORTHWEST LAGOON)]
INDEPENDENCE, JACKSON COUNTY, MISSOURI

TABLES

Table 2. Evaluation of Potential Public Health Hazards Associated with the Operable Units at LCAAP

Site	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Installation-Wide Operable Unit				
Area 1 Building 83 Wastewater Lagoons	Area 1 is located in the south-central portion of the plant. It is comprised of five unlined lagoons, used from the mid-1960s until 1988 to dispose of wastes generated during the production and neutralization of trinitroresorcinol .	**Surface Soil:** No surface soil sampling was conducted for this area. **Groundwater:** One SVOC bis(2-ethylhexyl) phthalate (B2EHP) (67 parts per billion [ppb]) was detected above its comparison value (CV). Metals detected above their CVs include arsenic (50 ppb), chromium (368 ppb), and lead (73.2 ppb). **Surface Water:** Lead (65.6 ppb) was detected above its EPA action level. Two explosives were detected above their CVs in the 1st round of sampling (1990); none were detected in the 2nd round (1992).	A remedial investigation (RI) has been completed. Four of the five lagoons were removed between 1986 and 1988 under an approved closure plan.	No public health hazard exists for groundwater, surface water, or sediment because access to the plant is restricted. There are no drinking water supply wells located in this area or in close proximity to the area of contamination.

		Sediment: Lead in one sample (858 parts per million [ppm]) was detected above its CV.		
Area 2 Building 85 Lagoons	Area 2 is comprised of several lagoons located near the south central edge of the plant. The original unlined lagoon, used from 1960 until 1972, was approximately 20,000 ft^2. Two larger clay-lined wastewater lagoons operated from 1972 until 1980. All three lagoons accepted wastes from Building 85, used for the manufacturing, formulation, and loading of lead-based initiating compounds, including tetrazine and lead styphnate.	**Surface soil:** Lead was detected at levels well above its CV (107,523 ppm). **Subsurface soil:** Arsenic and lead were detected above their CVs. **Groundwater:** One semi-volatile organic compound (SVOC), B2EHP (539 ppb), was detected above its CV. Some metals which were detected at levels above their CVs include arsenic (63 ppb), chromium (112 ppb), and lead (94,900 ppb). Sampling also identified alpha and beta radiation at levels that exceeded background concentrations.	An RI has been completed. The two large clay-lined lagoons were removed in 1990. An interim remedial action is expected to be completed by December 2001 (G. Anderson, Installation Restoration Program (IRP) Project Manager, LCAAP, personal communication, June 26, 2000).	This site poses no apparent public health hazard. Access to this area is restricted. However, there may be a continuing source of lead and other metals from the original unlined lagoon which may eventually flow into the East Fire Prairie Creek via surface water runoff and may also be a potential source of groundwater contamination.
Area 3 Sand Pits	Area 3 is located in the northwest corner of the plant near the main gate. The area contains pits and lagoons that were used to dispose of sludge and demolition waste from the Industrial Wastewater Treatment Plant (IWTP) from the 1950s to the early 1970s. Heavy metals, oil and grease, volatile organic compounds (VOCs), and uranium metallic compounds were deposited in this area.	**Soil:** No contaminants were detected above their CVs in surface soil. **Groundwater:** Trichloroethylene (TCE) (26 ppb) and 1,1-dichloroethene (1,1-DCE) (11 ppb) were detected in one well at levels above CVs. One SVOC, B2EHP, was detected above its CV. Explosives were detected mostly at levels below CVs. Eight metals were detected at levels above CVs, antimony (59.9 ppb), arsenic (170 ppb), barium (3,030 ppb), beryllium (18.4 ppb), cadmium (27.7 ppb), chromium (676 ppb), lead (470 ppb), and nickel (606 ppb).	An RI has been completed. No further action is proposed for this site.	No public health hazard exists since no contaminants were detected above CVs in surface soil and access to the plant is restricted. Groundwater for the plant is processed by air strippers to remove VOCs prior to its distribution and tested on a monthly basis for VOCs and some metals.
Area 4 Building 139 Backline Ponds	Area 4 is located in the south-central portion of the plant and has been used to store neutralized waste from Building	**Surface soil:** Arsenic (9.92 ppm) was detected above its CV.	An RI has been completed. The waste water lagoons were removed from 1985 to	No public health hazard is likely to exist in this area from exposure to

	139. Waste from the neutralization of lead styphnate slurry, treatment for lead azide contaminants, and neutralization of primer mixes and cyclotrimethylene trinitramine (RDX) were discharged to lagoons in the area.	**Groundwater:** TCE (4.8 ppb) was detected above its CV. One SVOC, B2EHP (13 ppb), was detected above its CV. Metals detected above their CVs include, antimony (68.2 ppb), barium (3,100 ppb), cadmium (34.4 ppb), chromium (335 ppb), lead (28 ppb), and nickel (29 ppb). **Sediment:** One metal, arsenic (52 ppm), was detected above its CV.	1987 under an approved closure plan. No further action is expected for this site.	soil. Access to the plant is restricted. There may be some potential for surface water runoff. It is not expected to be an important source of contamination for any surface water bodies. There are no drinking water supply wells in this area. Groundwater for the plant is processed by air strippers prior to its distribution and is not expected to pose a public health concern.
Area 5 Explosives Surface Impoundments	Area 5 is located in the south-central part of the plant. The primary solid waste management unit (SWMU) is the surface impoundment 5A which is about 7 feet deep and covers an area approximately 210 ft x 140 ft. Neutralized wastewater at Building 139 was discharged into a lagoon. The lagoon operated from about 1941 through 1988. Waste materials include heavy metals, such as lead, cadmium, and antimony, and explosive compounds.	**Subsurface soil:** One metal, total arsenic (10.1 ppm), was detected at levels above its CV. **Groundwater:** VOCs detected above their CVs include, TCE (400 ppb), vinyl chloride (40 ppb), and 1,2-dichloroethene (1,2-DCE) (400 ppb).	A preliminary assessment and site inspection (PA/SI) have been completed. Area 5 is currently undergoing a remedial investigation and feasibility study (RI/FS).	No public health hazard exists because the surface soil does not contain levels of contamination that would be harmful. Although the ground- water contains VOCs, there are no drinking water supply wells located in this area. Drinking water obtained from on-site supply wells contaminated with VOCs is processed by air strippers prior to its distribution.
Area 6 Building 65 Impoundments	Area 6 contains a surface impoundment approximately 151 ft x 162 ft. It is located just southeast of the center of the plant in the Fuze Line Manufacturing sector. Neutralized wastewater from Building 65, which is used for the packing of 20 mm cannon shells, was disposed of in this impoundment. It was closed in 1990.	**Soil:** No contaminants were detected above their CVs. **Groundwater:** No VOCs were detected above their CVs. One SVOC, B2EHP (459 ppb), was detected above its CV. Metals such as arsenic (96 ppb), chromium (188 ppb), nickel (277 ppb), and lead (60 ppb) were detected above their CVs. One explosive, RDX (14 ppb)	An RI has been completed. The surface impoundment was closed in 1990 under the Resource Conservation and Recovery Act in accordance with approved plans.	No public health hazard exists because the contamination source has been removed from the area and no contaminants have been detected above their CVs in surface soil. There are no drinking water supply wells located in this area.

		was detected above its CV.		
Area 7 IWTP Lagoons	Area 7 is located just west of the center of the plant. It comprises several different SWMUs, including IWTP lagoons, a fuel oil spill area, a buried solvent pit, closed burning ground, and a container cleanup area.	**Surface soil:** Lead (1,000 ppm) was detected at levels above its CV. **Groundwater:** VOCs detected above their CVs included vinyl chloride (10 ppb), 1,2-dichloroethane (15 ppb), TCE (32 ppb), and 1,1-DCE (1.5 ppb). One SVOC, B2EHP (150 ppb) was detected above its CV. One explosive, RDX (1,800 ppb) was detected above its CV. Five metals, antimony (88 ppb), arsenic (110 ppb), cadmium (26 ppb), lead (61 ppb), and nickel (128 ppb) were detected above their CVs. No contaminants were detected above their CVs in the drinking water supply wells. **Sediment:** Two explosives, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (131,000 ppm) and RDX (258,000 ppm), were detected above their CVs.	An RI has been completed. A draft of the feasibility study is scheduled to be completed by March 2001.	Based on available data no public health hazard exists. Most contaminants do not exceed CVs in surface soil and access to the area is restricted. Drinking water for the base is processed using air strippers prior to its distribution. The two drinking water supply wells located in this area are tested monthly for VOCs and some metals.
Area 8 Solid Waste Landfill	Area 8 is located in the southwestern corner of the plant. The area was used from the mid-1960s until 1988 to dispose of sludge from the IWTP. The area consists of eight unlined pits which were used to dispose of oil and grease from the IWTP. In addition, the area contains nine other earth pits used to dispose sludge and other IWTP-related materials, and to dispose of construction debris created during construction of the "Big Ditch."	**Subsurface Soil:** No VOCs were detected above their CVs. Two metals, lead (721 ppm) and arsenic (16 ppm), were detected above their CVs. **Groundwater:** VOCs detected above their CVs include 1,2-DCE (93 ppb) and TCE (15 ppb). These two VOCs were detected in sampling conducted in 1988. No VOCs were detected in monitoring wells sampled in 1990.	An RI/FS has been conducted. Eight unlined oil and grease pits were removed in 1989 under an approved closure plan. The sludge disposal pits are currently covered. At the time of the RI/FS, Area 8 was included as a separate OU. However, Area 8 has since been dropped as an OU and it is now included with the Installation-Wide OU.	This area does not pose a public health hazard because none of the contaminants exceeded CVs in surface soil and access to the area is restricted. There are no supply wells located in Area 8.

		One explosive, RDX (0.91 ppb) was detected above its CV. Metals detected above their CVs include lead (77 ppb), arsenic (102 ppb), cadmium (14 ppb), chromium (288 ppb), and nickel (211 ppb).		
Area 9 Building 60 (Mercurous Nitrate - Zinc Cyanide) Treatment Facility	Area 9 is located near the center of the plant, just south of Area 18. The facility was used to treat mercurous nitrate generated during testing of small arms and cartridges. Treatment of wastes is no longer taking place at this site. A sludge drying bed located next to the building was used from the late 1950s to early 1960s.	**Groundwater:** Cadmium (6.4 ppb) and nickel (122 ppb) were detected at levels above their CVs.	An RI/FS was conducted in 1990.	This area does not pose a public health hazard because of the low levels of contaminants detected and because access to the area is restricted.
Area 10 Firing Range Waste Dump	Area 10 is located in the east-central part of the plant and covers about 3 acres. It contains ammunition waste from ordnance used at the firing range, including armor piercing, incendiary, and depleted uranium.	**Surface soil:** No contaminants were detected above CVs. **Groundwater:** One SVOC, B2EHP (739 ppb), was detected at levels above its CV. Eight metals, antimony (11.5 ppb), arsenic (120 ppb), barium (5,190 ppb), beryllium (33 ppb), cadmium (81 ppb), chromium (1,100 ppb), lead (560 ppb), and nickel (872 ppb) were detected above their CVs. Radioactivity was detected in groundwater samples. Both alpha activity (62 pCi/L) and beta activity (211 pCi/L) were detected above Missouri groundwater stadards and national primary drinking water regulations.	An RI has been completed. The area has undergone cleanup activities for depleted uranium which is being overseen by the Nuclear Regulatory Commission.	This area poses no public health hazard because contaminants do not exceed CVs in surface soil. Access to the area is restricted and there are no drinking water supply wells located in this area. Alpha and beta radioactivity detected in groundwater does not pose a hazard since no completed past or current exposure pathway has been identified.
Area 12 NPL Lagoon and Paint Shop	Area 12 is located in the south-western portion of the plant just south of Buildings 6 and 10. From the late 1950s to the mid-1960s, two disposal lagoons, each covering approximately 10,000 ft^2, were used to	**Groundwater:** One VOC (TCE-200 ppb) was detected above its CV. Two SVOCs, N-nitrosodi-phenylamine (14 ppb) and B2EHP (26	A PA and SI have been completed.	No apparent public health hazard exists. Access to the area is restricted. On- site groundwater is processed through air strippers and treated prior to

	dispose of liquid wastes such as solvents and possibly small quantities of explosives from the chemical laboratory.	ppb), were detected at levels above their CVs. One metal, chromium (3,800 ppb) was detected above its CV. Two drinking water supply wells are located in Area 12. TCE (52 ppb) was detected in raw water in one of the supply wells (17-AA).		distribution. The drinking water supply is tested monthly for VOCs and some metals.
Area 13 Building 35 Drainage Area	Area 13 is located in the south-central section of the plant. Building 35 is the metal parts manufacturing facility, which until 1971 discharged sodium dichromate wastewater directly to the ground.	**Surface soil:** Three metals, antimony (9,000 ppm), total arsenic (9.3 ppm), and lead (48,000 ppm) were detected above their CVs. **Groundwater:** VOCs and metals were not detected above ATSDR's CVs. **Surface water:** Low levels of VOCs, SVOCs, and metals were detected. One explosive, 1,3-dinitrobenzene (131 ppb) was detected at levels above its CV.	A PA and SI have been completed. LCAAP is currently conducting a RI/FS for this area.	This area does not pose a public health hazard because access to Area 13 is restricted and prolonged exposure to surface soil or surface water is very unlikely. There are no drinking water supply wells located in this area.
Area 14 Burning Ground and Sludge Disposal Area	Area 14 is located in the north-central part of the LCAAP manufacturing area. The area contains a burning ground, used by the plant fire department to burn wooden ammunition boxes from 1951 through 1967, an IWTP sludge disposal area covering about 30,000 ft^2 which was closed in 1965, and four above ground fuel tanks located just north of the IWTP. Wastes include heavy metals and possibly explosives.	**Groundwater:** TCE was detected (45 ppb) in one sample above its CV. However, subsequent samples taken in the same location did not detect TCE. One SVOC, B2EHP (96 ppb) was detected in samples above its CV. One supply well (17-P) is located in this area. Vinyl chloride (5.3 ppb) was detected above its CV.	A PA and SI have been completed. No further action is planned.	This area does not pose a public health hazard. Access to the area is restricted. On-site groundwater is processed through air strippers and treated prior to use as drinking water.
Area 15 Temporary Surface Impoundment	Area 15 is in the south-central part of the plant and contains two SWMUs. One SWMU is a surface impoundment approximately 50 ft x 50 ft designed to temporarily hold wastes from Building 35. The impoundment was constructed during the 1970s and its use was discontinued prior to 1980.	**Surface soil:** Two metals, lead (2,200 ppm), and arsenic (34 ppm) were detected at levels above their CVs. **Groundwater:** Two metals, lead (17 ppm), and arsenic (80 ppb) were detected at	A PA and SI have been completed. An RI/FS is being conducted.	No public health hazard is likely to exist because access to the area is restricted. There are no supply wells located in this area.

	The other SWMU is a concrete lift station used to transfer wastes generated in Building 35.	levels above their CVs.		
Area 19 Sumps	Area 19, located just northwest of the center of the plant, was initially investigated as a sump area. A transformer pad is located southeast of Building 5. There may also be an underground storage tank used for holding laboratory waste, however, this has not been confirmed.	**Subsurface soil:** Very limited sampling showed low levels of Aroclor 1260 at concentrations of 0.63 and 2.11 ug/g, respectively in samples taken approximately 6 inches below the surface. These levels are below ATSDR's CVs.	A PA/SI has been completed. No further action is planned.	No public health hazard exists for this area because access is restricted and sampling data do not indicate that polychlorinated biphenals (PCBs) are present at harmful levels.
Area 20 Building 2 Area	Area 20 is located in the northwestern portion of the plant. This area comprises the grounds around and adjacent to Building 2. Some solvent spills were reported in this area. This area is not considered to be a significant source of contamination.	**Surface soil:** Sampling did not indicate significant contamination in this area and those contaminants that were detected were below their CVs.	A PA and SI have been completed.	No public health hazard exists because this area does not contain levels of contaminants that are considered harmful.
Area 21 Closed Sumps. Building 3A and 12A.	Area 21 is located just northwest of the center of the plant. The primary focus of the investigation was on the sump. One electrical substation was sampled for PCBs. This area also contains buildings 3A and 12A, which were used during the 1960s for the machining and assembly of depleted uranium-containing .50 caliber and 20mm ammunition.	**Surface soil:** Results of soil sampling for PCBs around the transformer were negative. No other sampling was conducted.	A PA and SI have been completed. Buildings 3A and 12A were decontaminated during 1985-1986. Inspection by Nuclear Regulatory Commission (NRC) officials indicated that additional cleanup activities were required for Building 3A. According to LCAAP, remediation of Building 3A will be completed by September 2001. The wing of building 3A that has been contaminated with depleted uranium will be torn down.	No public health hazard exists because this area does not contain levels of contaminants that are considered harmful.
Area 22 Demolition Waste Dump	Area 22 is located in the north-central part of the plant. The waste source is a demolition waste dump whose period of operation was believed to be during the 1940s and early 1950s.	**Surface soil:** Metals were detected at levels below their CVs. Beta radiation (15.7 pCi/g) was detected in soil. **Groundwater:** One SVOC, B2EHP (29 ppb) was detected above	A PA and SI have been completed.	This area does not pose a public health hazard. Access to this area is restricted and exposure to any radioactive sources would be of very short duration and not of public health concern.

		its CV. Beta activity (168 pCi/L) was detected from one sample location. However, later sampling showed that the beta activity was much lower.		On-site groundwater is processed through air strippers and treated prior to use as drinking water.
Area 23 Sludge Burial Pits	Area 23 is located just to the west of the center of the plant. The area covers approximately 34, 000 ft^2 and contains four IWTP sludge burial pits, located on the east side, which closed in 1967.	**Surface soil:** Very low levels of VOCs were detected.	A PA/SI has been completed. No significant concentrations of contaminants were detected and this area is not recommended for further action.	No public health hazard exists because this area does not contain levels of contaminants that are considered harmful.
Area 24 Sanitary Wastewater Treatment Plant	This area is where the former Sanitary Wastewater Treatment Plant was located. The plant is currently inactive and operated from 1941 until 1990. The Plant is no longer used because the industrial wastewater and sanitary wastewater streams were combined and transported to Little Blue Valley Sewer District.	No sampling has been conducted at this site.	No corrective activities are anticipated for this area.	This area does not pose a public health hazard because access to the area is restricted and the treatment plant was not used to process or treat industrial wastes.
Area 25 Demolition Debris Dump	This area is located in the southwest corner of the plant. Investigations of this area were not conducted since the area contains predominantly asbestos-related materials.	**Surface soil:** No investigations were conducted for this area. Contamination is predominantly asbestos related materials.	A PA and SI have been completed. The plant has an ongoing asbestos abatement program.	There is no apparent public health hazard. Access to this area is restricted, however, it is relatively close (about 0.5 mile) to the only housing area on the plant. This area should be closely monitored by plant security to ensure that children from on-site housing do not gain access.
Area 26 Roofing Tar Waste Dump	Area 26 is located near the southern perimeter of the plant. The waste dump is approximately 7,500 ft^2 and contains roofing tar materials.	**Surface soil:** SVOCs (total polycyclic aromatic hydrocarbons [PAHs]) (2,540 ppm) were detected at levels above their CVs. Two metals, arsenic (32 ppm) and lead (560 ppm), were detected above their CVs.	A PA and SI have been completed.	No public health hazard is likely to exist because access to this area is restricted.
Areas 27A and 27B Firing Range	The firing range has been in operation since the early 1950s to test all types of ammunition produced at LCAAP for	**Radiological survey:** Elevated radioactivity is present in the impact area in Area 27B.	A PA and SI have been completed. Investigations have been conducted by	No public health hazard is likely to exist because access to this area

	function and accuracy. Area 27A is located in the south-central portion of the plant. This area is associated with the firing range and contains various ordnance and radioactive elements. Area 27B is located in the eastern part of the plant. This area is associated with the firing range and contains various ordnance and radioactive elements.	**Groundwater:** Metals were detected at levels below their CVs. Alpha activity (101 pCi/L) and beta activity(240 pCi/L) were detected in groundwater. **Surface Water:** One explosive, RDX (50 ppb), was detected above its CV.	the NRC. Initial plans were to remove the materials contaminated with depleted uranium is scheduled for this area. Upon further review, the NRC has agreed to transfer regulatory oversight to the EPA CERCLA program and the removal of depleted uranium will be postponed.	is restricted. Contaminants in groundwater were below CVs and do not pose a health hazard. Transferring the oversight to EPA and not conducting an immediate removal is considered an acceptable short-term alternative because the firing range is still being used and the depleted uranium does not pose a public health hazard.
Area 28 Former Pipeline Leak	Area 28 is associated with an ARCO pipeline leak that reportedly occurred in the 1950s. There were no indications of contamination and the area was not investigated further.	There are no sampling data available.	A PA and SI have been completed. Due to the age of the reported spill it is not expected that evidence of the leak will be present. There is no need to investigate this area further.	No public health hazard exists because no contamination is likely from this old spill.
Area 29 Construction Landfill	Area 29 is located at the extreme western end of the plant. The area contains two construction debris landfills. The northern one was used during construction of the plant and the southern landfill was used during construction of the Big Ditch drainage diversion project between 1984 and 1987.	**Subsurface soil:** One metal, arsenic (15 ppb), was detected above its CV. **Groundwater:** One VOC, carbon tetrachloride (1.8 ppb), was detected above its CV. One SVOC, (B2EHP (28 ppb), was detected above its CV.	A PA and SI have been completed.	No public health hazard exists because this area does not contain levels of contaminants that are considered harmful.
Area 30 Demolition Dump	Area 30 is located in the northwest part of the plant and was used by the plant's fire department from 1951 to 1967 to burn wooden ammunition boxes. Wastes may include lead and explosive residues.	**Subsurface soil:** Antimony (1,730 ppm), arsenic (11.2 ppm), copper (220,000 ppm), and lead (200,000 ppm) were detected above their CVs. **Groundwater:** One SVOC, B2EHP (18 ppb) was detected above its CV.	A PA and SI have been completed.	No public health hazard is likely to exist because access to this area is restricted.
Area 31	Area 31 is located in the	**Surface soil:**	A PA/SI has been	Area 31 poses no

Firebreak Waste Dumps	northeastern corner of the plant. Waste includes assorted household debris and empty drums/ ammunition boxes scattered around the area. The site was likely active in the 1940s through the 1960s.	PAHs were detected in nearly half the soil samples collected. In two samples, seven PAHs were detected at levels greater than 1,000 ppm, well above their CVs. Some metals such as arsenic (420 ppm), lead (53,000 ppm), and mercury (170 ppm) were also detected above their CVs. **Groundwater**: No wells were installed in this area.	completed. No additional sampling is anticipated.	public health hazard because access to this area is restricted. There are no drinking water supply wells located in this area.
Area 32 Abandoned Houses	This area is located east of the center of the plant and contained approximately 10 abandoned houses. Only five houses are still intact and only two houses had any visible signs of contamination. One basement contained a number of empty 55-gallon drums which were removed prior to 1990.	**Surface soil:** One metal, lead (1,393 ppm) was detected at levels above its CV.	A PA and SI have been completed. All drums were removed in 1990. The source has been removed from the basement of one of the abandoned dwellings and the other abandoned house showed only one metal detection that exceeded its CV.	No public health hazard exists because access is restricted and the source of contamination has been removed.
Area 33 Building 53 Area Sumps	This area is located in the north-central region of the plant. Sumps were used for wash-down water during operations at several buildings at the area. These buildings were used for blending and pelletizing operations for RDX. Explosives and lead have been found on this site. Drains in the area were cemented closed during the 1970s.	**Surface soil:** One explosive, (RDX =502 ppm), was detected at levels above its CV. One metal, Lead (1,892 ppm), was also detected at levels above its CV.	A Pa and SI have been completed. No additional sampling is planned. Most past sampling results indicate little contamination of the area. No additional evaluation or remediation of this area is anticipated.	No public health hazard exists because access to this area is restricted.
Northeast Corner Operable Unit				
Area 11 Burning Grounds	Area 11 is located in the northeast part of the plant near Areas 16 and 17. The Area 11 Burning Grounds were used for open burning of explosive compounds from 1957 through 1994, and were required to be closed under State of Missouri hazardous waste regulations. The area may still be used for limited safety and training procedures.	**Soil:** No contaminants were detected above their CVs. **Groundwater:** Two metals were detected above their CVs, antimony (89 ppb) and cadmium (9 ppb). One explosive, RDX (96 ppb) was detected above its CV.	An RI/FS has been completed. An Interim Remedial Action record of decision (ROD) for the Northeast Corner OU was released in September 1998. Remedial plans include the installation of a subsurface permeable reactive wall (PRW) to treat contaminated	No public health hazard exists because access to this area is restricted. There are no drinking water supply wells located in this area.

			groundwater and a monitoring program to evaluate the effectiveness of the PRW. The PRW is expected to be completed by September, 2000 (G. Anderson, personal communication, IRP Project Manager, LCAAP, June 26, 2000). A final closure plan was approved for Area 11 in October, 1994.	
Area 16 Abandoned Landfill/Waste Glass, Paints, Solvents Area	Area 16 is located in the northeast part of the plant. The area contains five SIMUS: 1) an open burning ground operated from 1952 through 1957; 2) several small trenches which received solvents during the 1950s; 3) an area where five above-ground waste oil and solvents tanks were operated from 1980 through 1982; 4) an abandoned solid waste landfill which accepted plant-generated industrial/construction waste from 1970 through 1979; and 5) a pistol range used from 1952 through 1963.	**Soil:** Lead (3,000 ppm) and arsenic (49 ppm) were the only contaminants detected above their CVs. Lead was present in surface soil and arsenic was present in subsurface soil. **Groundwater:** No contaminants were detected above their CVs. **Surface Water:** One contaminant, lead (19 ppb) was detected above its CV.	A PA and SI have been completed. An FS is currently underway. Final ROD for Interim Remedial Action for this operable unit (OU) has been completed. A plan is in place to regrade the landfill cover to reduce infiltration and surface water runoff. The plan also includes phased planting of trees on the landfill cap to reduce VOCs in leachate and groundwater. A groundwater extraction well was installed as part of the LCAAP Groundwater Containment Program.	No public health hazard is likely to exist because access to the area is restricted. On-site groundwater is processed through air strippers and treated prior to use as drinking water. Monitoring of the groundwater plume will be necessary to ensure that contaminants do not migrate off site.
Area 17 Current Sanitary Landfill/Oil and Solvents Pits. The Waste, Glass, Paint, and Solvents Area.	Area 17 is located in the northeastern part of the plant, immediately east of Area 16. The area contains five SIMUS: 1) a currently permitted sanitary landfill; 2) three oil and solvent pits which received IWTP oil and grease, waste solvents, and waste oil from 1960 through 1980; 3) an area where wastes were disposed	*Oil and solvents pits -* **Soil borings:** VOCs detected above CVs include TCE (2,000 ppm), tetrachloro-ethylene (PCE) (420 ppm), 1,1,2-trichloroethane (62 ppm), and vinyl chloride (50 ppm). PAHs detected	A PA and SI have been completed. Final ROD for interim remedial Action for this OU has been completed. Soil cover over Area 17 solvent pits will reduce exposure to	No public health hazard is likely to exist because access to the area is restricted. On-site groundwater is processed through air strippers and treated prior to use as drinking

	of in shallow pits and a stream bed from 1960 through 1970; 4) an open burning pad which operated for a short period during 1975; and 5) a pistol range, which is currently used by the LCAAP security force.	above CVs include benzo(a)pyrene (2,000 ppm), benzo (a)-anthracene (3,000 ppm), benzo(b)- fluoranthene (5,000 ppm), and benzo(k)- fluoranthene (7,000 ppm). One metal, arsenic (50 ppm), was detected above its CV. **Groundwater:** VOCs detected above their CVs include TCE (4,000 ppb), PCE (1,000 ppb), 1,2-dichloroethene (300,000 ppb), toluene (8,000 ppb), 1,1,1-trichloroethane (2,400 ppb), 1,1,2-trichloroethane (160 ppb), and vinyl chloride (200 ppb). Two explosives, 1,3-DNB (237 ppb), and RDX (5.1 ppb) were detected above their CVs. Two metals were detected above their CVs, arsenic (121 ppb) and lead (202 ppb). *Waste, glass, paint, and solvents area -* **Soil:** Metals detected above their CVs include lead (16,000 ppm), and arsenic (42 ppm). **Surface Water:** Three metals, lead (79 ppb), arsenic (29 ppb), and cadmium (17 ppb) were detected above their CVs.	VOCs from contaminated soil and minimize further migration of VOCs to the groundwater by controlling runoff of precipitation. The placement of the soil cover will be completed at the same time the PRW is installed (G. Anderson, IRP Project Manager, LCAAP, personal communication, June 26, 2000).	water. The soil cover over the solvent pits is expected to reduce runoff and prevent contaminants from migrating off site. Monitoring of the groundwater plume will be necessary to ensure that contaminants do not migrate off site.
Area 18 Operable Unit				
Area 18 Burn Pits/ Lagoons/ Trenches Area	Area 18 is located in the north central part of the plant. The pits were used to burn plant construction debris and solvents. The pits were operated from 1952 through 1975.	**Surface Soil:** Two VOCs, TCE (60 ppm) and tetrachloroethylene (11 ppm), were detected above their CVs. **Groundwater:** VOCs detected above	Final ROD for this operable unit has been released.	No apparent public health hazard exists because access to this area is restricted. One former supply well (17-FF) located on the western

		their CVs include benzene (42 ppb), 1,1-DCE (35 ppb), 1,2-dichloro- ethylene (4,000 ppb), TCE (68 ppb), and vinyl chloride (8,000 ppb). Metals detected above their CVs include arsenic (16.8 ppb) and manganese (2,740 ppb). Groundwater extraction well (17-FF) contained two VOCs, 1,2-DCE (250 ppb) and vinyl chloride (150 ppb), which exceeded their CVs.		portion of Area 18 has been converted to a groundwater extraction well.

Source: EA Engineering 1994; EA Engineering 1995b; Burns&McDonnell 1999; USACHPPM 1998

1. Maximum concentration detected is presented

Table 3. Summary of Potential Exposure Pathways at LCAAP

Pathway Name	Source of Contamination	Environmental Medium	Point of Exposure	Route of Exposure	Potentially Exposed Population	Comments
LCAAP drinking water supply wells	Thirteen active production wells that draw water from the contaminated HU 2 water bearing zone at LCAAP.	Groundwater	Supply wells and connecting water distribution system across the plant.	Ingestion, dermal contact, and inhalation	Workers and visitors at LCAAP	**Past:** • Supply wells at LCAAP have contained VOCs slightly above CVs. These VOCs, however, were not found at levels that would cause adverse health effects. ATSDR concludes that exposure to past drinking water supplies at LCAAP posed no apparent public health hazard. **Current and Future:** • Air strippers have been connected to eight supply wells at LCAAP. This remedial measure has removed most VOCs and LCAAP's water supply meets Safe Water Drinking Standards. The water supply for LCAAP is tested monthly for VOCs and some metals. Recent tests do not show any contaminants that are at levels of concern.
Off-site private drinking water wells	Area 18 OU and the Northeast Corner OU contaminated groundwater plumes are a potential source of	Groundwater	Off-site private drinking water wells	Ingestion, dermal contact, and inhalation	Residents living to the north of the Area 18 OU and North East Corner OU.	**Past, current and future:** • Quarterly monitoring of some private wells to the north of the Area 18 OU and the Northeast Corner OU was conducted between 1987 and 1993.

	contamination for private wells located north of the plant.					Private wells to the north of the Area 18 OU and the Northeast Corner OU do not contain levels of VOCs or metals at levels that would pose an apparent public health hazard.
Soil	Waste disposal activities at LCAAP	Surface soil	Areas of contamination at LCAAP	Incidental ingestion and/or dermal contact	On-site residents, visitors, and adult workers	**Past:** • The entire base is fenced and access is restricted. On-site residents would not likely be exposed to contaminated soil because the housing area is located away from the main plant and most of the contamination sources are located in the industrial area of the plant where access is restricted. Any exposures would be infrequent and of short duration. Past exposures to soil most likely posed no public health hazard. **Current and Future:** • Remedial measures have removed contaminated surface soil from many of the areas. Interim controls and restricted access make it unlikely for exposures to be taking place or to take place in the future.
Surface water and sediment	Waste disposal activities at LCAAP	Surface water and sediment	Areas of contamination at LCAAP	Incidental ingestion and/or dermal contact	On-site residents, visitors, and adult workers	**Past:** • The entire base is fenced and access is restricted. On-site residents would not likely be exposed to contaminated surface water or sediment because the housing area is located away from the main plant and most of the contamination sources are located in the industrial area of the plant where access is restricted. The only surface water body routinely used for recreation is Veteran's Lake. This water body is not in close proximity to contaminated source areas. **Current and Future:** • Restricted access to areas of contamination make it unlikely for exposures to be taking place or to take place in the future. Interim controls and removal actions have helped to reduce the threat of

						contaminants migrating off site to surface water and/or sediment.
Air	Open burning of explosives on site, sealing operations units, and the Explosive Waste Incinerator (EWI).	Ambient Air	Ambient Air	Inhalation and/or ingestion	On-site and off-site residents, visitors, and workers at LCAAP.	**Past:** • Open burning of explosives was permitted in the past at LCAAP. In addition, VOC emissions may have occurred at the sealing operations units. Although ambient air monitoring was not conducted at LCAAP in the past, it is unlikely that ambient air concentrations would have been high enough to pose a health hazard. For this reason, past air exposures pose no apparent public health hazard. **Current and future:** • Exposures to air contaminants are not likely to cause harmful exposures since open burning is no longer permitted, source reduction of VOCs has significantly reduced emissions from the sealing operations units, and the EWI has a pollution control system which removes harmful contaminants before stack gases are released.

FIGURES

Figure 1. LCAAP Location Map

Figure 2. LCAAP Operable Unit (OU) and Source Area Map

Figure 3. ATSDR's Exposure Evaluation Process

PUBLIC HEALTH ASSESSMENT

LAKE CITY ARMY AMMUNITION PLANT
[(a/k/a LAKE CITY ARMY AMMUNITION PLANT (NORTHWEST LAGOON)]
INDEPENDENCE, JACKSON COUNTY, MISSOURI

APPENDICES

APPENDIX A. LIST OF COMPARISON VALUES

Comparison values represent media-specific contaminant concentrations that are used to select contaminants for further evaluation to determine the possibility of adverse public health effects. The conclusion that a contaminant exceeds the comparison value does not mean that it will cause adverse health effects.

Cancer Risk Evaluation Guides (CREGs)
CREGS are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10^{-6}) persons exposed over their lifetime. ATSDR's CREGs are calculated from EPA's cancer potency factors (CPFs).

Maximum Contaminant Level (MCL)
The MCL is the drinking water standard established by EPA. It is the maximum permissible level of a contaminant in water that is delivered to the free-flowing outlet. MCLs are considered protective of public health over a lifetime (70 years) for individuals consuming 2 liters of water per day.

Environmental Media Evaluation Guides (EMEGs)
EMEGs are based on ATSDR minimal risk levels (MRLs) that consider body weight and ingestion rates. An EMEG is an estimate of daily human exposure to a chemical (in mg/kg/day) that is likely to be without noncarcinogenic health effects over a specified duration of exposure to include acute, intermediate, and chronic exposures.

Reference Media Evaluation Guides (RMEGs)
ATSDR derives RMEGs from EPA's oral reference doses. The RMEG represents the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects.

APPENDIX B: GLOSSARY

Background Level:
An average or expected amount of a chemical in a specific environment. Or, amounts of chemicals that occur naturally in a specific-environment.

Comparison Values:
Concentrations or the amount of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse

health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.

Concentration:
How much or the amount of a substance present in a certain amount of soil, water, air, or food.

Dose:
The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as "amount of substance(s) per body weight per day".

Environmental Contaminant:
A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than that found in **Background Level**, or what would be expected.

Environmental Contamination:
The presence of hazardous substances in the environment. From the public health perspective, *environmental contamination* is addressed when it potentially affects the health and quality of life of people living and working near the contamination.

U.S. Environmental Protection Agency (EPA):
The federal agency that develops and enforces environmental laws to protect the environment and the public's health.

Exposure:
Coming into contact with a chemical substance.(For the three ways people can come in contact with substances, see **Route of Exposure**.)

Ingestion:
Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).

Media:
Soil, water, air, plants, animals, or any other parts of the environment that can contain contaminants.

Minimal Risk Level (MRL):
An estimate of daily human exposure - by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.

National Priorities List (NPL):
The **N**ational **P**riorities **L**ist. (Which is part of **Superfund**.) A list kept by the U.S. Environmental Protection Agency (EPA) of the most serious, uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people can be exposed to chemicals from the site.

No Apparent Public Health Hazard:
The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals may have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.

No Public Health Hazard:
The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.

Parts per Billion (ppb)/ Parts per Million (ppm):

Units commonly used to express low concentrations of contaminants. As example of each, one part per billion (ppb) of trichloroethylene (TCE) equals one drop of TCE mixed in a competition-size swimming pool and one part per million (ppm) equals one ounce of trichloroethylene (TCE) in one million ounces of water.

Potentially Exposed:

The condition where valid information, usually analytical environmental data, indicates the presence of contaminant(s) of a public health concern in one or more environmental media contacting humans (i.e., air, drinking water, soil, food chain, surface water), and there is evidence that some of those persons have an identified route(s) of exposure (i.e., drinking contaminated water, breathing contaminated air, having contact with contaminated soil, or eating contaminated food).

Public Health Assessment:

A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.

Public Health Hazard:

Sites that pose a public health hazard as the result of long-term exposures to hazardous substances.

Reference Dose (RfD):

An estimate, with safety factors (see **safety factor**) built in, of the daily, life-time exposure of human populations to a possible hazard that is not likely to cause harm to the person.

Route of Exposure:

The way a chemical can get into a person's body. There are three exposure routes:

- breathing (also called inhalation),
- eating or drinking (also called ingestion), and
- or getting something on the skin (also called dermal contact).

Safety Factor:

Also called **Uncertainty Factor**. When scientists don't have enough information to decide if an exposure will cause harm to people, they use "safety factors" and formulas in place of the information that is not known. These factors and formulas can help determine the amount of a chemical that is not likely to cause harm to people.

Volatile organic compounds (VOCs):

Substances containing carbon and different proportions of other elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulfur, or nitrogen; these substances easily become vapors or gases. A significant number of the *VOCs* are commonly used as solvents (paint thinners, lacquer thinner, degreasers, and dry cleaning fluids).

APPENDIX C. ESTIMATED EXPOSURE AND HEALTH EFFECTS

Estimates of Human Exposure Doses and Determination of Health Effects

Deriving Exposures Doses

The Agency for Toxic Substances and Disease Registry (ATSDR) typically evaluates the public health implications of exposure by considering the contaminant's chemical class, concentration of the contaminants to which people may have been exposed, and how often and how long exposure to these contaminants occurred. Together, these factors help influence the individual's response to chemical exposure and potential noncancer and cancer outcomes. ATSDR estimated the human exposure doses from ingestion of water containing volatile organic compounds (VOCs) from the supply wells at LCAAP and from off-site private wells north of LCAAP. In the absence of complete exposure-specific information, ATSDR applied several conservative exposure assumptions to define site-

specific exposures as accurately as possible for workers and visitors to the plant, the small number of adults and children living at the housing area, and individuals who drink water from off-site private wells.

Evaluating Potential Health Hazards

The estimated exposure doses are used to evaluate potential noncancer and cancer effects associated with chemicals of concern. When evaluating *noncancer* effects, ATSDR uses standard toxicity values, including ATSDR's minimal risk levels (MRLs) and EPA's reference doses (RfDs) to determine whether adverse effects are likely to occur. The chronic MRLs and RfDs are estimates of daily human exposure to a substance that are unlikely to result in adverse noncancer effects over a specified duration. To be very protective of human health, MRLs and RfDs have built in "uncertainty" or "safety" factors that make them much lower than levels at which health effects have been observed. Therefore, if an exposure dose is much higher than the MRL or RfD, it does not necessarily follow that adverse health effects will occur.

When evaluating *cancer* effects, ATSDR sometimes uses cancer potency factors (CPFs) that define the relationship between oral exposure doses and the increased likelihood of developing cancer over a lifetime. The CPFs are developed using data from animal or human studies and often require extrapolation from high exposure doses administered in animal studies to the lower exposure levels typical of human exposure to environmental contaminants. CPFs represent the upper-bound estimate of the probability of developing cancer at a defined level of exposure; therefore, they tend to be very conservative (i.e., overestimate the actual risk) in order to account for a number of uncertainties in the data used in the extrapolation. ATSDR estimated the potential for cancer to occur using the following equation (The estimated exposure doses and CPF values for the contaminants of concern are incorporated into the equation):

Lifetime Cancer Risk = Estimated exposure dose (mg/kg/day) x CPF $(mg/kg/day)^{-1}$

Although no risk of cancer is considered acceptable, it is impossible to achieve a zero cancer risk. Consequently, ATSDR often uses a range of 10^{-4} to 10^{-6} estimated lifetime cancer risk (or 1 new case in 10,000 to 1,000,000 exposed persons), based on conservative assumptions about exposure, to determine the likelihood of excess cancer resulting from this exposure.

In addition to estimating the likelihood of noncancer and cancer effects, ATSDR reviewed the literature to evaluate possible health effects associated with exposure at the doses/concentrations estimated for the pathway described below.

Estimated Exposure Dose for Consumption of VOCs in Drinking Water

In estimating to what extent people might be exposed to VOCs, ATSDR used the following equation and applied "conservative" or safe assumptions about possible human exposure. ATSDR assumed that a person drank the most contaminated well water. ATSDR also used conservative assumptions about how often people drink water and how much they drink. These assumptions allow ATSDR to estimate the highest possible exposure dose and determine the corresponding health effects. Although ATSDR expects that few individuals, if any, were exposed to the highest levels of contamination, the "conservative" estimates are used to protect public health. The following describes the equation and assumptions used to estimate the exposure:

$$\textit{Estimated exposure dose} = \frac{\text{Conc. x CF x IR x EF x ED}}{\text{BW x AT}}$$

where:

Conc.: Maximum concentration of VOCs in the well water (ppb)

CF: Conversion factor to convert ppb to parts per million (1/1,000)

IR: Ingestion rate: adult=2 liters per day; child=1 liter per day

EF: Exposure frequency or number of exposure events per year of exposure: 7 days/week x 52 weeks/year

ED: Exposure duration or the duration over which exposure occurs: adult=30 years; child=6 years

BW: Body weight: adult=70 kg (154 pounds); child=10 kg (22 pounds)

AT: Averaging time or the period over which cumulative exposures are averaged (6 or 30 years x 365 days/year for noncancer effects or 70 years for cancer)

The estimated exposure doses are expected to be very conservative values because they are based on the following assumptions.

- ATSDR estimates that an adult drank 2 liters and a child drank 1 liter of water a day and that all drinking water came from the supply wells at LCAAP. This assumption likely leads to an overestimate of the actual exposure dose because individuals most likely drank water from other sources.

- The exposure frequency (EF), or number of exposure events per year, was assumed to be 365 days per year, based on a 7-day-a-week exposure over 52 weeks per year. This maximum exposure frequency would only pertain to the small number of individuals who lived on site at the time that the supply wells were used as a drinking water source for the housing area. Workers at LCAAP would have a much shorter exposure frequency.

- The duration of exposure (ED) is assumed to have occurred over a 30-year period for adults. For a child, ATSDR used a 6-year exposure duration.

- The maximum concentration of contaminants detected in any of the supply wells was used. It is extremely unlikely that anyone would be exposed at these levels because water from all 13 supply wells is blended prior to distribution.

Past Exposures from the On-Site Drinking Water Supply at LCAAP

VOCs in four supply wells (17-AA, 17-FF [no longer used for drinking water], 17-K, and 17-P) at LCAAP exceeded ATSDR's health-based comparison values (CVs) for drinking water in the past. To determine whether *past* exposure to these contaminants in the plant's drinking water supply may have caused adverse health effects, ATSDR estimated exposure doses for people consuming water containing the highest measured concentrations detected in the wells. The estimated exposure doses were then used to evaluate potential noncancer and cancer outcomes.

Noncancer: ATSDR estimated exposure doses from ingestion of water from the LCAAP supply wells containing trichloroethylene (TCE), tetrachloroethylene (PCE), 1,2-dichloroethene, and vinyl chloride (see Table C-1). No chronic (365 days and longer) oral MRL or RfD is currently available for TCE. ATSDR also recently withdrew the intermediate (15-364 days) MRL for TCE. The study on which the intermediate MRL was based has been questioned because it contains certain flaws and limitations (e.g., the exact amount of TCE-contaminated water consumed by laboratory animals in the study is uncertain) (ATSDR 1997c).

In the absence of health-based guidelines, ATSDR reviewed the available toxicological literature to determine possible adverse effects associated with exposure at doses estimated for this pathway. On the basis of this review, the exposure doses estimated for TCE by ATSDR are several orders of magnitude lower than the lowest doses reported in the toxicological literature capable of producing noncancer effects in animals administered oral doses of TCE (ATSDR 1997c). Therefore, drinking water containing the highest detected levels of TCE reported in on-site supply wells at LCAAP is not likely to result in adverse noncancer effects.

The resulting estimated exposure dose for PCE (adults and children) and the exposure dose for 1,2-DCE (adults) are lower than their RfD. Exposures to these two chemicals at the levels detected should not be associated with adverse health effects. The exposure dose for 1,2-DCE for children is slightly higher than its RfD of 0.02 mg/kg/day, but the slightly higher dose is not of health consequence because the exposure doses estimated for 1,2-DCE by ATSDR are several orders of magnitude lower than the lowest doses reported in the toxicological literature capable of producing noncancer effects in animals administered oral doses of 1,2-DCE.

The estimated exposure dose for vinyl chloride, for both adults and children, is higher than its MRL of 0.00002 mg/kg/day. A review of the literature shows that the lowest dose of vinyl chloride in which noncancer effects were observed involved a chronic exposure animal study. This study found slight changes in cellular structure after animals were fed 0.02 mg/kg/day of polyvinylchloride powder for approximately 3 years. For most other studies, the lowest observed adverse effect level (LOAEL) was two orders of magnitude (i.e., 2.0 mg/kg/day) greater than the 0.02 mg/kg/day dose (ATSDR 1997d). Using the most conservative assumptions, the maximum estimated dose for a child was 0.03 mg/kg/day, which is in the range of the LOAEL reviewed in the literature.

Although the estimated dose for vinyl chloride (adult and child) exceeded ATSDR's MRL, it is unlikely that individuals who consumed the drinking water from LCAAP were exposed to harmful levels of this contaminant. The estimated doses of vinyl chloride were based on the maximum concentration detected (270 ppb) in one supply well, but it is not expected that anyone drank water containing that concentration. (The average level of vinyl chloride from this supply well was much lower [125 ppb] (Dames & Moore 1999). This supply well was one of 13 wells used to supply LCAAP with drinking water. Vinyl chloride was only detected in three of 13 supply wells. It is also important to note that water from the 13 supply wells is mixed and blended in a large (500,000 gallon) holding tank and no one at LCAAP is drinking water from one supply well. Therefore, it is almost certain that levels of vinyl chloride and 1,2-DCE in the finished water supply would have been much lower than the maximum concentrations used to estimate doses.

In addition, ATSDR assumed that individuals at LCAAP were drinking water from LCAAP 365 days a year. However, it is unlikely that any individual obtained their drinking water exclusively from one source. According to LCAAP representatives, individuals who have

lived in the on-site housing area usually only do so for a short time, perhaps 3 or 4 years. The estimated dose calculated assumed that individuals were being exposed for 30 years.

For the reasons described above, ATSDR concludes that ingestion of TCE, PCE, 1,2-DCE, and vinyl chloride, from the LCAAP water supply in the past is not expected to have resulted in adverse health effects.

Cancer: TCE and PCE have been shown to cause cancer in laboratory animals given large doses. The link between TCE and cancer in humans is uncertain, however. Available studies are inconclusive and the data are inadequate to establish a link. For screening purposes ATSDR used a previously derived CPF for TCE of 0.011 $(mg/kg/day)^{-1}$ and for PCE of 0.052 $(mg/kg/day)^{-1}$. The slope factors for these chemicals are under review. ATSDR derived cancer risk estimates for exposure to TCE and PCE that fall within the range (less than 10^{-5}) considered acceptable. On the basis of these results, ATSDR concludes that ingestion of either TCE or PCE at the levels detected in the on-site well water is not likely to result in an increased risk of developing cancer (see Table C-2).

No studies were identified regarding cancer in humans following oral exposure to vinyl chloride. There currently is no CPF for vinyl chloride based on human studies, however, there is strong evidence from inhalation studies in humans and inhalation and oral studies in animals to suggest that it is a carcinogen. EPA has concluded that sufficient evidence of carcinogenicity exists in humans and has classified vinyl chloride as a Group A (human) carcinogen. A large number of studies have reported a greater than expected incidence of a rare type of cancer, angiosarcoma of the liver, among workers exposed to vinyl chloride (ATSDR 1997d). Chronic oral studies found an increase in liver angiosarcoma in animals fed 0.3 mg/kg/day (ATSDR 1997d). The maximum exposure dose estimated for an adult consuming water from LCAAP is about two orders of magnitude lower than that found to increase liver tumors in animals. Based on this information and the very conservative exposure assumptions used, ATSDR does not expect that ingestion of vinyl chloride from the LCAAP water supply would result in an increased likelihood of developing cancer.

Off-Site Private Wells

Three VOCs were detected above CVs during LCAAP's monitoring of 12 residential wells conducted from July 1988 through September 1993. Benzene (1.1 ppb), TCE (6.4 ppb), and 1,1-DCE (2 ppb) were detected at levels slightly above their CVs. With the exception of TCE, which was detected twice above its CV, the other two chemicals were only detected one time above their CVs during the entire monitoring period.

Noncancer: ATSDR estimated exposure doses from ingestion of water from the off-site private wells for benzene, TCE, and 1,1-DCE (see Table C-3). An RfD or MRL was available for 1,1-DCE, but was not available for benzene and TCE.

ATSDR's review of the literature shows that the lowest no observed adverse effect level for benzene in animal studies was 1 mg/kg/day (ATSDR 1997a). The maximum estimated exposure for benzene for a child in private wells was about four orders of magnitude lower than what was observed in any of the studies identified. The exposure doses estimated for TCE by ATSDR are five orders of magnitude lower than the lowest doses reported in the toxicological literature capable of producing noncancer effects in animals administered oral doses of TCE (ATSDR 1997c). For 1,1-DCE, the estimated dose was lower than the RfD reported in Table C-3. Based on the maximum estimated dose and a review of the toxicologic literature, ATSDR concludes that ingestion of benzene, TCE, or 1,1-DCE at the levels detected in off-site private wells is not expected to result in adverse health effects.

Cancer: ATSDR derived cancer risk estimates for exposure to benzene, 1,1-DCE, and TCE that fall within the range (less than 10^{-5}) considered acceptable by ATSDR. ATSDR concludes that cancer effects are unlikely to be experienced as a result of drinking water drawn from the off-site wells (see Table C-4).

Source:

Agency for Toxic Substances and Disease Registry (ATSDR). 1994. Toxicological Profile for 1,1-dichloroethene. Update. May 1994.

ATSDR. 1996. Toxicological Profile for 1,2-dichloroethene. Update. August 1996.

ATSDR. 1997a. Toxicological Profile for Benzene. Update. September 1997.

ATSDR. 1997b. Toxicological Profile for Tetrachloroethylene. Update. September 1997.

ATSDR. 1997c. Toxicological Profile for Trichloroethylene. Update. September 1997.

ATSDR. 1997d. Toxicological Profile for Vinyl Chloride. Update. September 1997.

Dames & Moore. 1999. 1998 Annual Report for LCAAP Comprehensive Groundwater Monitoring Program. August 1999.

Table C-1. Estimated Exposure Doses--Noncancer Effects
Ingestion of Drinking Water at LCAAP

Contaminant	Maximum Detected Contaminant Concentration (ppb)	Estimated Exposure Dose (mg/kg/day)[a]		Health Guideline (mg/kg/day)	Basis for Health Guideline
		Adult	Child		
1,2-Dichloroethene	380	0.01	0.04	0.02	RfD
Tetrachloroethylene	1.7	0.00005	0.0002	0.01	RfD
Trichloroethylene	52	0.001	0.005	not available	----
Vinyl chloride	270	0.008	0.03	0.00002	MRL

[a] $\textit{Estimated Exposure Dose} = \frac{\text{Conc. x CF x IR x EF x ED}}{\text{BW x AT}}$

Conc. = Maximum contaminant concentration in on-site supply wells (ppb).
CF = Conversion factor to convert ppb to ppm (1/1000)
IR = Ingestion rate: adult = 2 liters per day; child = 1 liter per day
EF = Exposure frequency or the number of exposure events (7 days x 52 weeks or 365 days per year)
ED = Exposure duration or the duration over which exposure occurs: adults = 30 years; child = 6 years
BW = Body weight (kg): adult = 70 kg (154 pounds); child = 10 kg (22 pounds)
AT = Average time or the period over which cumulative exposures are averaged (6 or 30 years x 365 days)

Key: ppb = parts per billion; mg/kg/day=milligrams contaminant per kilogram body weight per day; MRL = ATSDR's minimal risk level; RfD= EPA's reference dose.

Table C-2. Estimated Exposure Doses--Cancer Effects
Ingestion of Drinking Water at LCAAP

Contaminant	Maximum Contaminant Concentration (ppb)	Estimated Exposure Dose (mg/kg/day) [a]	Cancer Potency Factor $(mg/kg/day)^{-1}$	Lifetime Cancer Risk
Tetrachloroethylene	1.7	0.00002	0.052[b]	1×10^{-6}
Trichloroethylene	52	0.0006	0.011[b]	7×10^{-6}
Vinyl chloride	270	0.003	not available	-----

[a] $\textit{Estimated Exposure Dose} = \frac{\text{Conc. x CF x IR x EF x ED}}{\text{BW x AT}}$

[b] These cancer potency factors are currently under review by EPA.

Conc. = Maximum contaminant concentration in the on-site supply wells (ppb)
CF = Conversion factor to convert ppb to ppm (1/1000)
IR = Ingestion rate: 2 liters per day
EF = Exposure frequency, or the number of exposure events (365 days per year)
ED = Exposure duration, or the duration over which exposure occurs = 30 years
BW = Body weight (kg): 70 kg (154 pounds)
AT = Average time or the time over which cumulative exposures are averaged (70 years x 365 days)

Key: ppb = parts per billion; mg/kg/day=milligrams contaminant per kilogram body weight per day.

Table C-3. Estimated Exposure Doses--Noncancer Effects
Ingestion of Drinking Water From Private Wells

Contaminant	Maximum Detected Contaminant Concentration (ppb)	Estimated Exposure Dose (mg/kg/day)[a]		Health Guideline (mg/kg/day)	Basis for Health Guideline
		Adult	Child		

Benzene	1.1	0.00003	0.0001	not available	----
1,1-Dichloroethene	2	0.00006	0.0002	0.02	RfD
Trichloroethylene (TCE)	6.4	0.0002	0.0006	not available	----

[a] $\text{Estimated Exposure Dose} = \frac{\text{Conc. x CF x IR x EF x ED}}{\text{BW x AT}}$

Conc. = Maximum contaminant concentration in off-site private wells (ppb)
CF = Conversion factor to convert ppb to ppm (1/1000)
IR = Ingestion rate: adult = 2 liters per day; child = 1 liter per day
EF = Exposure frequency or the number of exposure events (365 days per year)
ED = Exposure duration or the duration over which exposure occurs: adults = 30 years; child = 6 years
BW = Body weight (kg): adult = 70 kg (154 pounds); child = 10 kg (22 pounds)
AT = Average time or the period over which cumulative exposures are averaged (6 or 30 years x 365 days)

Key: ppb = parts per billion; mg/kg/day=milligrams contaminant per kilogram body weight per day.

Table C-4. Estimated Exposure Doses--Cancer Effects
Ingestion of Drinking Water From Private Wells

Contaminant	Maximum Contaminant Concentration (ppb)	Estimated Exposure Dose (mg/kg/day) [a]	Cancer Potency Factor $(mg/kg/day)^{-1}$	Lifetime Cancer Risk
Benzene	1.1	0.00001	0.029	4×10^{-7}
1,1-Dichloroethene	2	0.00002	0.6	1×10^{-5}
Trichloroethylene	6.4	0.00008	0.011[b]	8×10^{-7}

[a] $\text{Estimated Exposure Dose} = \frac{\text{Conc. x CF x IR x EF x ED}}{\text{BW x AT}}$

[b] These cancer potency factors are currently under review by EPA.

Conc. = Maximum contaminant concentration in off-site private wells (ppb)
CF = Conversion factor to convert ppb to ppm (1/1000)
IR = Ingestion rate: 2 liters per day
EF = Exposure frequency, or the number of exposure events (1 event x 7 days x 52 weeks or 365 days per year)
ED = Exposure duration, or the duration over which exposure occurs = 30 years
BW = Body weight (kg): 70 kg (154 pounds)
AT = Average time or the time over which cumulative exposures are averaged (70 years x 365 days)

Key: ppb = parts per billion; mg/kg/day=milligrams contaminant per kilogram body weight per day.

APPENDIX D: RESPONSE TO PUBLIC COMMENTS

The Public Health Assessment (PHA) for Lake City Army Ammunition Plant (LCAAP) was available for public review and comment from October 3, 2000 through November 22, 2000. The public comment period was announced in a press release on October 4, 2000. Copies of the public health assessment were made available for review at the Mid-continent Public Library, Blue Springs, Missouri and the LCAAP information repository. The PHA was also sent to state and federal agencies for review. Upon request from LCAAP officials, ATSDR extended the public comment period until July 26, 2001 so that comments received from the July 26, 2001 public availability

session could be incorporated into the final release document.

The following are responses to EPAs comments pertaining to ATSDRs Public Comment Release.

***Comment 1**: In general, we disagree with your conclusions regarding the prospects of public health hazards associated with past, current, or future exposures to releases of hazardous substances from the LCAAP. Regarding past exposures, we do not believe sufficient data is available to determine whether potentially negative health impacts associated with past exposures may have occurred. Further, we do not agree that conditions at the site are currently adequately controlled such that potential exposures (and associated health impacts) will likely not occur in the future. Given site conditions, in the absence of further response actions by the Army, we believe it highly possible that significant exposures to hazardous substances could occur. We also believe that land use at the LCAAP may be subject to significant changes in the short term, based on what the Army terms its' "facilities use" approach. Such changes in land use could dramatically alter the nature of potential exposures and subsequent health risks.*

Response: ATSDR acknowledges EPAs difference in opinion regarding the conclusions contained in the PHA. In the process of conducting a public health assessment (PHA), ATSDR evaluates whether a completed exposure pathway has occurred in the past, is occurring currently, or is likely to occur in the future. When a completed pathway has been identified, ATSDR evaluates whether exposures are at levels that would contribute to adverse health effects. ATSDR recognizes that some hazardous contamination generated from activities at LCAAP continues to be present on site. However, ATSDR bases its public health conclusions not only on whether contamination is present, but also on whether it is likely that people will come in contact with levels of contaminants that may be harmful. Based on the available data that was provided to ATSDR, there is no evidence of past, current, or future public health hazards. ATSDR agrees that continued monitoring of groundwater plumes beneath LCAAP is necessary to make sure that off-site migration is not taking place.

***Comment 2:** Page 1, Summary, Paragraph 5 - We suggest you consult with the Army/LCAAP regarding the schedule for completing a ROD for the Installation-Wide OU. It may be appropriate to provide more specific information regarding the anticipated ROD date for this OU.*

Response: According to information provided by LCAAP representatives, an Interim Remedial Action ROD for metals contaminated soil for the Installation-wide OU is scheduled to be signed in the Fall 2001. LCAAP is still working on a schedule for releasing a final ROD for the Installation-wide OU, which will include both remediation of non-metal contaminants in soil and groundwater.

***Comment 3:** Page 2, Summary, Paragraph 4 - The PHA should indicate the basis for concluding that exposures to contaminants in private wells pose no apparent past, current, or future public health threat. In the absence of continued and/or additional response actions by the Army, the prospects for exposures and health threats are quite likely in the future.*

Response: In evaluating the potential for past, current, and future health effects from drinking water, ATSDR estimated the lifetime exposure dose for both an adult and a child who drink water containing the maximum concentration of the chemical detected in either on-site supply wells at LCAAP or off-site private drinking water wells located north of LCAAP. Appendix C in the PHA provides a complete description of the methods and assumptions ATSDR used to estimate exposure. As explained in Appendix C, the dose estimates calculated are based on very conservative assumptions that have built in safety factors. ATSDR recognizes that there may be some exposure to contaminants in drinking water, however, the concentrations that have been detected in off-site private wells and in the LCAAP drinking water supply wells are not at levels considered to pose a health hazard. This evaluation is based on toxicological profiles of the chemicals detected in the drinking water.

ATSDR has recommended that LCAAP resume routine monitoring of private wells north of the Area 18 and Northeast Corner OU. According to LCAAP representatives, this monitoring is scheduled to be resumed in the spring/summer 2001 (personal communication with Garth Anderson, March 5, 2001).

***Comment 4:** Page 2, Summary, Paragraph 5 - The PHA should indicate the basis for the conclusions presented here, to clarify the assumptions regarding possible land use at LCAAP.*

Response: ATSDR concluded that on-site soil and surface water contamination did not pose a past or does not pose a current or future public health hazard because access to LCAAP is restricted and sampling has indicated that most soil and surface water contamination is generally confined to areas near the source with no evidence of migration off site. Under LCAAP's "facility use" plan, any new land use must be reviewed by LCAAP and the Operations Support Command. Any proposed reuse of land must meet existing legal agreements and conditions , including land use restrictions and institutional controls agreed upon by LCAAP.

Comment 5: *Page 3,* Summary*, Paragraph 2 - We believe this paragraph accurately states that "...there are not data to evaluate whether contaminants released into the air were present at levels that were harmful...". Based on this statement, it is unclear how you conclude that past exposures presented minimal health threats when insufficient data is available to support this conclusion.*

Response: ATSDR must often rely on limited information when evaluating past public health hazards. When activities or operations at a site are known to have resulted in some past environmental contamination (e.g., groundwater or air), ATSDR first identifies and reviews whatever historical monitoring data is available. In cases where no monitoring data is available, ATSDR collects as much information about the nature and extent of releases into the environment.

Based on correspondence with LCAAP officials, open burning activities took place at designated open burn areas, primarily in the northeastern portion of the plant, approximately once a week as long as certain weather conditions were met. Open burns were conducted under certain weather conditions to prevent or minimize smoke and air particulates from impacting off-site residents.

According to historical information from LCAAP, approximately 300 pounds of primarily propellant and wet explosive scrap were burned per week. This amount was significantly below the LCAAP permit allowing for up to 240 pounds per day or a maximum of 1,440 pounds per week. Open burning activities were significantly reduced after the explosive waste incinerator was brought up to incinerator standards in 1989. Open burning activities were no longer conducted at LCAAP after 1993.

Based on the relative infrequency of open burns, the precautionary measures taken to prevent smoke and air particulates from impacting residents, and the very small number of residences north of LCAAP, ATSDR concludes that past exposures would not likely pose a health hazard. Although monitoring data is not available for these past activities, ATSDR has based this public health conclusion on the best available information.

Comment 6: *Page 5,* Background*, Paragraph 2 - Alliant Techsystems is the current operating contractor for the LCAAP, assuming operations from Olin in April 2000. We suggest you confer with the LCAAP to ensure accurate information in this paragraph.*

Response: ATSDR has confirmed with LCAAP that Alliant Techsystems is the current operating contractor and this will be reflected in the final PHA.

Comment 7: *Page 7,* Background*, Paragraph 2 - Suggest that the text be revised to reflect that the Remedial Investigation for the Northeast Corner OU is still in progress. Suggest that a more specific date for the Installation-Wide OU ROD be provided.*

Response: ATSDR has received updated information concerning the status of the remedial investigation for the Northeast Corner OU and this will be reflected in the final PHA. According to an LCAAP representative, the release date for the Installation-Wide OU ROD is still under negotiation.

Comment 8: *Page 10,* QA/QC *- Suggest you briefly discuss the evaluation process employed to determine the adequacy of the available data for making public health decisions.*

Response: As noted in the PHA, reports that are prepared for the Comprehensive Environmental Response, Compensation, and Liability Act and the Resource Conservation and Recovery Act programs must meet specific standards for quality assurance and quality control. In addition to this, ATSDR reviews data from site-related reports and evaluates whether detection limits are set at levels that are protective of public health. ATSDR also notes any inconsistencies or problems with data collection or reporting and evaluates whether the information is adequate to be used for making public health decisions. ATSDR will make the suggested changes noted above.

Comment 9: *Page 12,* Conclusions *- We believe insufficient information is available to determine the nature of possible past exposures/health hazards associated with groundwater at/from LCAAP.*

The PHA should clarify that the presence of drinking water of acceptable quality at LCAAP is predicated on the continued operations, maintenance, and monitoring of existing water treatment operations.

The PHA should clarify that the prevention of future exposures to contaminants in groundwater beyond LCAAP boundaries is predicated on continued operations, maintenance, and monitoring of existing response actions, and the implementation of additional actions to control releases of hazardous substances at the LCAAP.

Please correct the last paragraph to indicate that contaminants are present in groundwater at the northern plant boundary at levels above (order of magnitude) that which would pose a health threat if consumed regularly. It should be clarified that this contamination has likely migrated beyond the plant boundary, but that the nature and extent of the off-

plant contamination has not been completely defined. Also, please note the presence of a groundwater contaminant plume in the western part of LCAAP, which has potential to migrate off-plant.

Response: As noted above, ATSDR estimated the dose, for both an adult and a child, of chemicals detected in drinking water wells above ATSDRs CVs. ATSDR used the maximum concentration detected in supply wells at LCAAP in order to provide a worst case scenario. Appendix C in the PHA explains the assumptions used in calculating an individual's exposure dose.

ATSDR will modify the text of the PHA to include a statement that clarifies that the safety of individuals consuming drinking water at LCAAP relies on continued water treatment and routine monitoring of the drinking water supply.

In response to the last paragraph of comment # 9, the statement on page 12 of the PHA specifically refers to contaminants detected in off-site drinking water wells. Although VOCs and metals were detected in some of these wells, the concentrations were not at levels that pose a public health hazard. VOCs were detected in untreated LCAAP drinking water supply wells [17KK (TCE-3.6 ppb) and 17K (TCE-1.5 ppb)] and in monitoring wells [16-18 (1,2-Dichloroethene-10.7 ppb); TCE-13.9 ppb)] near the northern plant boundary during 1999. However, groundwater sampling of supply wells and monitoring wells near the northern boundary showed a declining trend in VOC concentrations compared to 1998 data. ATSDR will clarify that contamination has the potential to migrate beyond the plant boundary and that it is important for LCAAP to characterize the nature and extent of contamination north of LCAAP. ATSDR will also clarify that the nature and extent of the groundwater plume in the western portion of the plant should also be characterized due to the potential for it to migrate off site.

Comment 10: *Page 13,* Physical Characteristics *- The notion of "hydrostratigraphic units" is not truly a physical feature, but one defined for purposes of modeling, primarily. It may be appropriate to edit or simplify much of this discussion.*

Response: ATSDR will note in the text that hydrostratigraphic units are not actual physical hydrogeological features, but were developed to help conceptualize how groundwater flows underneath LCAAP. ATSDR will consider clarifying or simplifying any discussion in this section where appropriate.

Comment 11: *Page 15,* On-Site Groundwater Contamination*, Paragraph 1 - The PHA should consider that results of sampling from water supply wells may not be representative of aquifer/groundwater conditions. Given the dilution that will occur in a water supply well, unlike in a groundwater monitoring well, groundwater contamination may be much more significant than the sampling results indicate.*

Response: As noted previously, ATSDR identifies whether a completed exposure pathway exists. If a completed pathway is identified, ATSDR evaluates whether this exposure is likely to cause adverse health outcomes using very conservative assumptions (e.g., estimating dose using the maximum concentration detected in drinking water supply wells).

Regardless of the levels of contamination detected in groundwater or any other environmental media, it is important to emphasize that a public health hazard exists only if people come in contact with or are exposed to harmful levels of contaminants. ATSDR evaluated the potential for treated drinking water at LCAAP to contain harmful levels of chemicals. Routine monitoring of the LCAAP drinking water supply has confirmed that the treated water that is used for drinking at LCAAP meets state and federal drinking water standards. ATSDR has not identified any individuals at LCAAP that are drinking water from untreated groundwater sources and, therefore, people are not being exposed to levels of contamination that would be harmful.

Comment 12: *Page 16,* On-Site Groundwater Contamination*, Paragraph 2 - The PHA should indicate that groundwater contamination extends to, and likely beyond, the northern boundary of the LCAAP.*

Response: ATSDR will add that the nature and extent of contamination beyond the northern plant boundary has yet to be determined and it is possible that groundwater contamination has migrated off site.

Comment 13: *Page 18,* Off-Site Groundwater Contamination*, Paragraph 1 - The PHA states, based on a personal communication, that LCAAP groundwater extraction wells prevent most off-site migration. In terms of protectiveness, there could be a significant difference between preventing most and all off-site contaminant migration. We suggest that you supplement this personal communication with evaluation of existing records or assessments which address the effectiveness of the extraction wells in containing groundwater contamination, and that you clarify what is meant by the statement that most off-site migration is prevented.*

Response: Although there may be some migration of the Area 18 and Northeast Corner OU contaminant plume, according to the 1999 Annual Report for LCAAP Groundwater Monitoring Program, which presents data from 1988 through 1999, the monitoring wells located on the northern perimeter have generally shown decreasing trends in

contaminant levels. For example, in Monitoring Well 16-17, TCE levels in groundwater have decreased from 57 ppb in 1996 to 13.9 ppb in 1999.

ATSDR cannot definitively say that *all* off-site contaminant migration has been prevented since the nature and extent of the plume needs to be further delineated. However, based on toxicological profiles of TCE and other contaminants identified in these monitoring wells, even if people were currently exposed to the maximum concentrations that are present in northern boundary monitoring wells, such exposures would not be harmful.ATSDR expects that site-related contaminants would either not be detected or detected at much lower concentrations in the closest private wells north of LCAAP. Because the plume needs to be better defined, however, ATSDR has recommended that quarterly monitoring of private wells north of LCAAP be reinstated.

Comment 14: *Page 18,* Off-Site Groundwater Contamination*, Paragraph 2 - The PHA states, based on a personal communication, that the presence of lead and cadmium may have been an "artifact". Since the notion of the contamination being an "artifact" is interpretive and not necessarily supported by facts, we suggest you remove this statement.*

Response: This statement has been removed and the paragraph has been revised.

Comment 15: *Page 20,* Current and Future Exposures, On-site *- The PHA should clarify that the water supply (i.e. aquifer) has not necessarily met drinking water standards, but that the treated water, prior to consumption, has met drinking water standards. It is important to highlight that a continuing treatment process is required for drinking water at the LCAAP to meet protective standards.*

Response: This distinction will be clarified in the text of the PHA.

Comment 16: *Page 20,* Current and Future Exposures, Off-site *- While the operation of the groundwater extraction well at the northern LCAAP boundary may prevent further migration of contaminants in groundwater off-plant, the nature and potential impacts of contamination which may have migrated off-plant prior to the installation of the extraction well is unknown.*

Response: Because of the uncertainty regarding the nature and extent of groundwater contamination north of LCAAPs Area 18 and the Northeast Corner OU, ATSDR has recommended in the PHA that quarterly monitoring of private wells be reinstated.

Comment 17: *Page 22,* Evaluation of the Soil Exposure Pathway*, Conclusion - Remedial actions have not yet been planned or implemented which will address all areas of contamination which may pose an unacceptable risk at the LCAAP.*

Response: ATSDR will confirm with LCAAP which areas of soil contamination at LCAAP have not been addressed, either through planned or past remediation or through other interim measures.

Comment 18: *Page 23,* Northeast Corner OU*, Paragraph 1 - The PHA refers to a "final ROD for Interim Remedial Action...". We suggest you eliminate the term "final" in describing the interim action, as it may be confusing to some readers.*

Response: ATSDR will edit the text accordingly.

Comment 19: *Page 23,* Area 18 OU *- The Army has proposed, based on data collected subsequent to the Area 18 ROD, that the Area 18 ROD be amended or revised, and that the multi-phase vapor extraction system may not be effective in addressing site contaminants. EPA, the Missouri Department of Natural Resources, and the Army are currently in the process of evaluating the Army proposal regarding the Area 18 Remedial Action. Suggest that you may want to reflect some uncertainty in the status of Area 18 to reflect that VOC contamination may be more widespread than was anticipated at the time of the ROD and that the Army and regulators are considering the most appropriate manner in which to proceed.*

Response: This information for the Area 18 OU will be reflected in the final release of the PHA.

Comment 20: *Page 23,* Installation-Wide OU *- Suggest that you indicate that additional data collection and site evaluation is warranted to better define the nature and extent of contamination, and thus potential remedies, for a number of the 31 areas referenced.*

Response: This suggestion will be incorporated into the final PHA.

Comment 21: *Page 34,* Public Health Action Plan*, Actions Ongoing or Planned - In #4, we are uncertain of the nature of any formal (enforceable) land-use restrictions which have been implemented at the LCAAP as part of any CERCLA*

response actions. Please clarify the nature of these restrictions.

In #5, we suggest you note that monitoring of off-plant groundwater contamination, downgradient of the Area 18 extraction system is planned/necessary.

Response: According to the ROD for Remedial Action at the Area 18 OU released in February 1998, part of the selected remedy for Area 18 OU is to prohibit agricultural (e.g., cattle grazing) and other non-industrial uses. In addition, as part of the remedial measures defined in the Final ROD for interim remedial action at the Northeast Corner OU, LCAAP is to restrict on-site worker's access to contaminated soil.

Regarding the suggestion for planned action (#5). In 1992 eight groundwater monitoring wells were installed just off site to the north of the Area 18 and the Northeast Corner OU. According to data presented in the Annual Report for LCAAP Comprehensive Groundwater Monitoring Program, these monitoring wells have not contained levels of VOCs that exceed EPA's maximum contaminant levels. The following clarification will be incorporated into the final PHA: ATSDR recommends continued routine monitoring of off-site groundwater contamination, downgradient of the Area 18 extraction system. New monitoring wells should be installed off site in any locations where data gaps may be occurring.

Comment 22: *Page 35,* Public Health Action Plan*, Recommendations - In #2, we agree that surface water sampling at LCAAP is appropriate, but suggest that regular surface water monitoring (rather than a one-time sampling event) should be conducted over a limited number of rounds, perhaps quarterly for 2-5 years (depending on results), to better evaluate possible releases of contaminants to surface water.*

Response: ATSDR agrees that routine monitoring of surface water for a specified time period is appropriate and the text will be revised accordingly.

The following are ATSDRs responses to a list of questions provided by a representative of LCAAPs Restoration Advisory Board. The questions listed below are those that pertain specifically to ATSDRs Public Comment Release. Some of the questions were directed to LCAAP and responded to by LCAAP and are not listed below (the numbers in parentheses correspond to the actual number on the original list provided).

Questions submitted to ATSDR January 23, 2001.

Comment (#1): *What is the actual date of the compiled information in the recent public health assessment report by the ATSDR?*

Response: ATSDR relied on the most currently available information at the time of the release of the public health assessment (Public Comment Draft) to base its public health conclusions. Environmental sampling data for LCAAP was collected as part of a preliminary assessment/site investigation released in January 1989 and remedial investigations for the Installation-Wide Operable Unit (OU) (February 1994), Area 18 OU (January 1995), and the Northeast Corner OU (March 1995). The on-site drinking water supply monitoring data was obtained for 1999, which was the most recent sampling period available. The drinking water monitoring data from the City of Independence and the Missouri Department of Health were collected in1998, the most recent time periods available prior to the release of the Public Comment Draft. ATSDR will continue to evaluate new information as it becomes available and will revise its public health conclusions and recommendations accordingly.

Comment (#3): *Please provide me with a map of LCAAP indicating all the areas in the ATSDR report that state access to this area is restricted.*

Response: ATSDR has not identified a site map that indicates areas at LCAAP that have restricted access. However, ATSDR has corresponded with LCAAP regarding access restrictions to the plant. According to LCAAP officials, the entire plant perimeter is fenced with several gated entry points around the plant. These entry points are either locked or have a guard posted. There is no evidence that trespassing onto LCAAP property has been a problem in the past. In addition to the perimeter fence, there is an inner fence that runs along and just south of Buckner Road. This fence encompasses about two-thirds of the plant, including the entire industrial area. There is also a fence around the firing range and special permission is required to access this area. Although most of the designated areas of contamination on site are not fenced, they are contained within the plant perimeter and public access is restricted.

Comment (#6): *Why is the ATSDR public health assessment report titled Northwest Lagoon which is Area #12 paint shop?*

Response: This area is responsible for LCAAP being placed on EPAs National Priorities List (NPL). LCAAP was first logged into ATSDR's tracking system in reference to Area 12, as the "LCAAP Northwest Lagoon". Even though the PHA covers the entire facility, to ensure consistent record-keeping the formal title of the PHA is "Lake City Army Ammunition

Plant (Northwest Lagoon).

Comment (#10)**:** *Please explain uranium metallic compounds as stated in Area #3 sand pits.*

Response: In the February 1994 RI report for LCAAP it was stated that some uranium metallic compounds were reportedly disposed of by the Department of Energy's Kansas City (Bendix) operations. However, investigations at Area 3 did not identify any radiological sources. According to this report, slightly elevated beta activities compared with background in soil were detected (range = 5 - 6.4 pCi/kg) during the source characterization. Two groundwater monitoring well locations in Area #3 out of a total of 20 were found to have alpha activities that exceeded ATSDR's comparison values (CVs). The maximum alpha level detected was 41 pCi/L (CV = 15 pCi/L).

Comment (#11): *Please provide complete explanation ATSDR report page #27 (*evaluation of air exposure pathway*)- conclusion.*

Response: As stated in the Nature and Extent section of the PHA, the primary sources of air emissions from LCAAP in the past were the sealing operations units, open burning/open detonation of wet pyrotechnics and propellant powder, and the Explosives Waste Incinerator.

Sealing Operations Units -
In the past, the sealing operations units did release some VOCs and ozone depleting chemicals. These chemicals were specifically used in the case mouth waterproofing areas and primer insert operations. According to LCAAP officials, solvents used in these areas include ethyl acetate, methyl chloroform, ethyl alcohol, methyl ethyl ketone, and toluene. The sealing operations units are located in the industrial area near the center of the plant. These VOCs would not have resulted in harm to individuals who reside near LCAAP because releases were near the center of the plant, the quantities of solvents used were relatively small, and VOCs are rapidly dispersed once released into the atmosphere.

Open Burning/Open Detonation -
The burning grounds were constructed in the middle 1950's. LCAAP operated the burning ground area for the open burning/open detonation of waste explosives, mixes, and powders. Burning activities were generally conducted once a week as long as specific weather conditions were met. Based on historical information, approximately 300 pounds of materials per week were burned at LCAAP. The most common materials burned were propellant and wet explosive scrap (e.g., calcium resinate, magnesium, barium peroxide, polyvinyl chloride, and propellant powder). The permitted burn rate for these wastes could not exceed 240 pounds per day, every day for a maximum of 1,440 pounds per week. Based on historical information, LCAAP was well under the permitted rates averaging about 60 pounds per day. According to LCAAP officials, open burning/open detonation activities were stopped in1993 (correspondence with Paul Anthamatten, March 2001). LCAAP did not conduct ambient air monitoring during burning activities and based on correspondence with Plant officials, no unusual burn events or incidents took place and ATSDR is not aware of any complaints from residents living near LCAAP during the time period that open burning /open detonation occurred.

Explosives Waste Incinerator (EWI) -
According to LCAAP officials the EWI meets all current emissions standards and has not received any notice of violations during its period of operation. The EWI was brought up to incinerator standards in 1989. Prior to 1989, it was operated as a popping furnace to incinerate small quantities of materials.

Air Pathway Public Health Hazard Determination -
Since actual air monitoring data was not available, ATSDR based its public health conclusion on historical information (e.g., types of materials, quantities, and frequency with which operations or activities occurred). ATSDR's designation of "no apparent public health hazard" recognizes that some past exposures were possible from the sealing operations units and open burning/open detonation activities, however, it is unlikely that these exposures were at levels that would pose a public health hazard.

Comment (#12): *The ATSDR public health assessment report is based on available information, and due to the fact that all is not known about the LCAAP site, would this report not be considered inconclusive and not construed as no "public health hazard"?*

Response: When evaluating whether exposure has occurred, ATSDR considers how people might come into contact with, or be exposed to, contaminated media, and also considers the likely length (duration) and frequency of the exposure. If exposure was or is possible, ATSDR then considers whether chemicals were or are present at levels that might be harmful to people. It is important to emphasize that a public health hazard exists only if people come in contact with, or are otherwise exposed to, harmful levels of contaminated media.

ATSDR does not always have historical monitoring data to make conclusive statements regarding the potential for past exposures. However, if past monitoring data is not available, ATSDR identifies the best available information in which to

base its conclusions (e.g., potential receptor populations, current monitoring data, complaints filed or other community concerns) and decides whether it is likely that public health hazards may have existed in the past, may currently exist, or are likely to exist in the future.

When there is no information or very limited information available about a specific exposure pathway at a site, ATSDR may decide that additional data needs to be collected and evaluated to determine whether a public health hazard has existed in the past or currently exists. Depending on the hazard potential of the site and the feasibility of collecting additional data, the pathway may be designated an indeterminate public health hazard. Based on correspondence with LCAAP officials and given what is known about the types and extent of chemicals used at the plant, ATSDR has concluded that the overall Public Health Hazard Category for LCAAP is "No Apparent Public Health Hazard." This classification recognizes that for certain pathways at LCAAP exposure to contaminants has occurred in the past or may be occurring at levels that are not likely to cause adverse health effects. ATSDR's assessment process is ongoing and ATSDR will reevaluate its conclusions as new information becomes available.

Comment (# 13): *The ATSDR public health assessment report states several times and consequently in several areas that no public health hazard exists due to the supposed fact that access to the plant and or certain areas are restricted. However, one of the main objectives seems to be to increase the occupancy at LCAAP, therefore how can this be safely achieved?*

Response: One of the recommendations made by ATSDR in the Public Health Action Plan of the LCAAP PHA (p35) is that any area(s) of the plant that is/are leased out undergo a final evaluation for environmental contaminants to meet the standards of safety and public health of the intended use. According to LCAAP officials, any designated area at LCAAP that is considered for a new use must be suitable for the type of activities that will be conducted. Any new facilities use request at LCAAP must follow a formal evaluation and approval process. Any proposed reuse of land at LCAAP must be reviewed by LCAAP and Operations Support Command. Any proposed plan must meet the existing legal agreements and conditions put forth by regulatory agencies regarding land use restrictions and institutional controls.

Comment (#14): *It is stated several times in the ATSDR report pertaining to several different areas that there are no drinking water supply wells located in this area. However, what is the likelihood that these identified contaminants could leach into the water supply and or migrate from the site by other means, such as becoming airborne or surface water runoff and consequently in the water supply?*

Response: ATSDR evaluates all potential exposure pathways and considers worst case exposure scenarios when evaluating whether a public health hazard exists. Environmental studies have shown that, in certain locations, the groundwater underneath LCAAP is contaminated. However, off-site monitoring wells and private well sampling data have not identified any contamination that would pose a public health hazard. A few of the off-site private wells have contained very low levels of metals and VOCs and ATSDR recommends that these wells be routinely monitored in the future to ensure that the water remains safe for drinking. Surface water has been sampled at LCAAP and there is no evidence that contamination is migrating off site at levels that would be of concern. ATSDRs evaluation of groundwater, surface water, sediment, and air exposure pathways has not identified any contamination migrating off site that would pose a public health hazard.

Comment (# 15): *The ATSDR report states that for area #25, there were no tests conducted in this area due to the stated fact that this area contains predominantly asbestos related materials and access is restricted. Why were no tests conducted of this area and why is air sample monitoring not necessary?*

Response: According to LCAAP officials, this landfill is covered with soil and vegetation. There is no completed air pathway since construction debris and asbestos related materials are not accessible.

Comment (#16): *The ATSDR report - area #21 specifically, building 3A and 12A, were used for machining and assembly of depleted uranium (DU) and also states "no public health hazard exists." Was this area tested for DU contamination?*

Response: Both of these buildings have been tested for DU. Initial inspections by the Nuclear Regulatory Commission (NRC) indicated that building 3A required some additional cleanup of radiological contamination. Specifically, the floors of the southeast wing of building 3A were found to be contaminated with DU. LCAAP has conducted additional decontamination and is waiting final inspection by NRC. Any surface areas or soil samples which do not meet the established cleanup standards will undergo further remediation as required. Cleanup activities are expected to be completed by the end of September, 2001. According to the Environmental Baseline Survey (USCHPPM), Building 12A does not require any additional clean up measures to be taken.

Comment (#17): *The ATSDR report, specifically area #27A and #27B, contain DU and it was further stated that removal of the DU was to be completed by the end of 2000. Was this completed?*

Response: According to LCAAP officials, the cleanup of Area 27A is scheduled to be completed by the end of September 2001. For Area 27B, the NRC has setup an agreement with the EPA to transfer regulatory oversight to the EPA CERCLA program. The firing range continues to be used by LCAAP and the area is restricted by an interior fence and only authorized personnel are allowed inside the area.

Comment (# 18): *ATSDR report area #28 refers to a pipeline leak that occurred in the 1950's and that there were no indications of contamination, and yet the report also states that there are no sampling data available and that no public health hazard exists due to the age of the spill. Why were no samples taken and would this leach into a water source?*

Response: During the preliminary site investigations at LCAAP, investigators attempted to identify the pipeline spill. According to correspondence with LCAAP, investigators were unable to find the spill or any residual contamination. Sampling was not deemed necessary because it was unlikely that any residual contamination would be identified in soil or groundwater samples.

Comment (# 19): *Was the ATSDR public health assessment report conclusion, page #67, regarding off-site private drinking wells released in the year 2000 based only on testing that occurred between 1987 to 1993 seven years prior to the release of this report?*

Response: In March 1998, the Missouri Department of Health conducted additional off-site sampling of 6 residential wells to the north of the plant (northwest quadrant). The drinking water in these wells met state and federal drinking water standards. Although LCAAP stopped the monitoring of private wells in 1993, off-site monitoring wells just north of LCAAP have not indicated that contaminants are migrating off site. ATSDR does recommend that routine private well monitoring be reinstated to ensure that drinking water continues to met safe drinking water standards. Based on this information, the hazard designation for off-site groundwater contamination was "no apparent public health hazard." ATSDR will continue to evaluate new information and modify conclusions accordingly.

Comment (# 20): *ATSDR report page #70 (summary of potential pathways at LCAAP) - air - states that ambient air sampling was not conducted in the past and other than the explosives waste incinerator; site specific ambient air sampling of contaminated sites are to date still not taking place. Why? Please explain.*

Response: According to LCAAP officials, open burning/open detonation no longer takes place at LCAAP. New technologies have substantially reduced or eliminated the use of solvents and ozone depleting chemicals in the sealing operations units. Besides the Explosives Waste Incinerator, which is closely monitored by LCAAP, there are no other significant air emissions occurring at LCAAP.

Comment (# 21): *ATSDR report area #22 states that exposure to radioactive sources would be of very short duration. Please explain.*

Response: Area # 22 is accessed infrequently by plant personnel and the amount of exposure from radionuclides in soil would be very minimal. Access to LCAAP is restricted and only visitors or the occasional trespasser may be present on site property. It is unlikely that visitors or trespassers will come in contact with Area # 22 and any exposures from infrequent contact with soil would note pose a health hazard.

Additional comments sent to ATSDR July 17, 2001

Comment 1**:** *Based on ATSDR parameters pertaining to exposure to contaminants and of sufficient magnitude and duration for a health hazard to exist, what are or could become health hazards on or off LCAAP if one or more current safeguards at LCAAP were to fail and shouldn't this be included in the public health assessment?*

Response: At present the environmental safeguards consist of access restriction, which includes a gate and security around the perimeter of LCAAP and an inner fence around the industrial area. In addition to restricting access to unauthorized individuals, other safeguard measures that have been implemented include soil removal actions at source areas of contamination and groundwater remediation such as pump-and-treatment systems and air strippers for the removal of VOCs. Failure of access restriction would only likely be in the form of a breach in fencing, which would be temporary. Levels of contamination in most source areas at LCAAP are not high enough to present a public health hazard for reasonable, short-term exposure for any scenarios which might occur. Failure of the groundwater containment system or of air strippers would be detected by monitoring systems, with repairs being initiated in a reasonably short time. Groundwater contamination levels are not high enough to present a public health hazard for short-term exposures.

Comment 2: *What are the potential health hazards to the residents, employees, and community regarding any contaminants leaching into the groundwater supply due to the known fact that all contaminants exist, and to the unknown fact that all contaminants are being 100 percent contained on and off LCAAP property and in addition that the*

magnitude of contamination of all known areas is not completely certain and/or that all contaminanted areas conclusively have been discovered?

Response: This public health assessment describes in detail the potential exposures of the community to environmental contaminants from LCAAP. Extensive environmental studies have been conducted under the oversight of state and federal regulators. It is very unlikely that unidentified areas of contamination exist at LCAAP since preliminary assessments and site investigations have sampled suspected areas of contamination throughout LCAAP. Groundwater underneath LCAAP has been extensively monitored and the drinking water on site is closely monitored for the presence of contamination. Off- site monitoring wells to the north of the plant have thus far not detected contaminants that would pose a public health hazard to residents who obtain their drinking water from shallow or intermediate wells. ATSDR recommends that LCAAP continue quarterly off site monitoring of groundwater to ensure that it continues to meet safe drinking water standards.

Comment 3: *Has and will ATSDR's public health assessment report take into consideration the various types of hazardous waste permits now in effect at LCAAP?*

Response: The purpose of the ATSDR public health assessment is to evaluate the potential public health effects of hazardous chemicals in the event that they are released into the environment. Oversight of the waste permitting process is the responsibility and mission of state and federal regulators. ATSDR is confident that the oversight by these regulators of the waste permits is sufficient to assure safe handling of these materials.

Comment 4: *What are the potential health hazards to the community regarding any contaminated groundwater run-off flowing into Fire Prairie Creek and consequently off LCAAP property?*

Response: The potential exposures to contaminants is described in preceding sections of this PHA. Surface water sampling conducted off site has not identified any contaminants that would pose a public health hazard. As a precautionary measure, ATSDR has recommended that surface water and sediment sampling at Fire Prairie Creek be routinely sampled to ensure that surface water is not contaminated.

Comment 5: *Due to the uncertainty of types, areas, and magnitude of contamination, is it responsible to make a conclusive public health assessment statement that no public health hazard exists?*

Response: As described above, there have been extensive studies conducted to define the extent of contamination in the environment at LCAAP. Based on an evaluation of these studies, ATSDR has concluded that the contamination in soil, water, and air at LCAAP has not resulted in a past, current, or future public health hazard.

Comment 6: *What are the potential health hazards to the residents, employees, and community in regards to various types of hazardous waste stored and/or treated at LCAAP?*

Response: As discussed in #3 above, waste treatment and storage are regulated and monitored by state and federal agencies. Current hazardous waste management practices at LCAAP are closely monitored and harmful environmental releases are not expected to occur in the future. Although past releases of contaminants into the environment has occurred and monitoring of contaminants generally began during the 1980's, ATSDR's public health assessment did not identify practices or conditions at LCAAP that would have likely resulted in a public health hazard. If any future releases are of sufficient magnitude that additional public health evaluation is believed to be necessary ATSDR can conduct additional evaluations.

Comment 7: *Due to the various types of contamination/hazardous waste at LCAAP, isn't it prudent to take random air samples at set intervals at various sites on and off LCAAP property?*

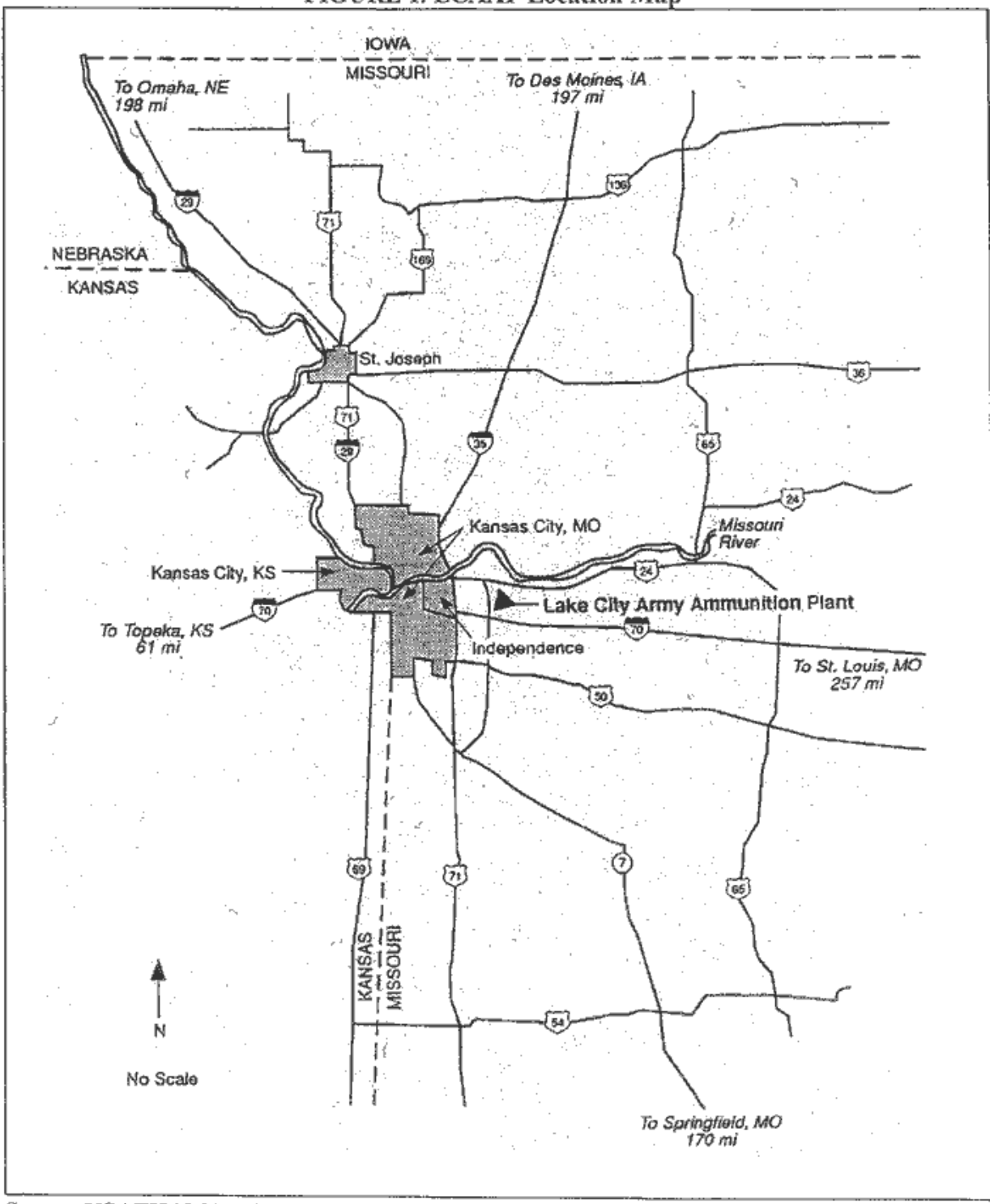
Response: The nature and extent of releases to the air are discussed in this public health assessment. These consist of low level past releases of solvents from the sealing operations unit at LCAAP during normal operations; smoke from open burning of relatively small amounts of ordnance; and regulated and monitored normal operational emissions from the on-site incinerator. Based on discussions with plant personnel and reviews of site documents, ATSDR has concluded that these emissions were not likely harmful in the past. Additional measures to reduce VOC air emissions have been taken at LCAAP in an effort to phase out ozone depleting chemicals used in the manufacturing process. These actions have further reduced the likelihood of any potential exposures and, therefore, current and future air emissions are not expected to present a public health hazard.

Comment 8: *What are or could be potential health hazards in regards to contaminants and/or stored hazardous waste pertaining to non-facility municipal firefighters or utility workers om LCAAP property?*

Response: Standard operating procedures involving coordination between LCAAP and fire-fighting personnel are

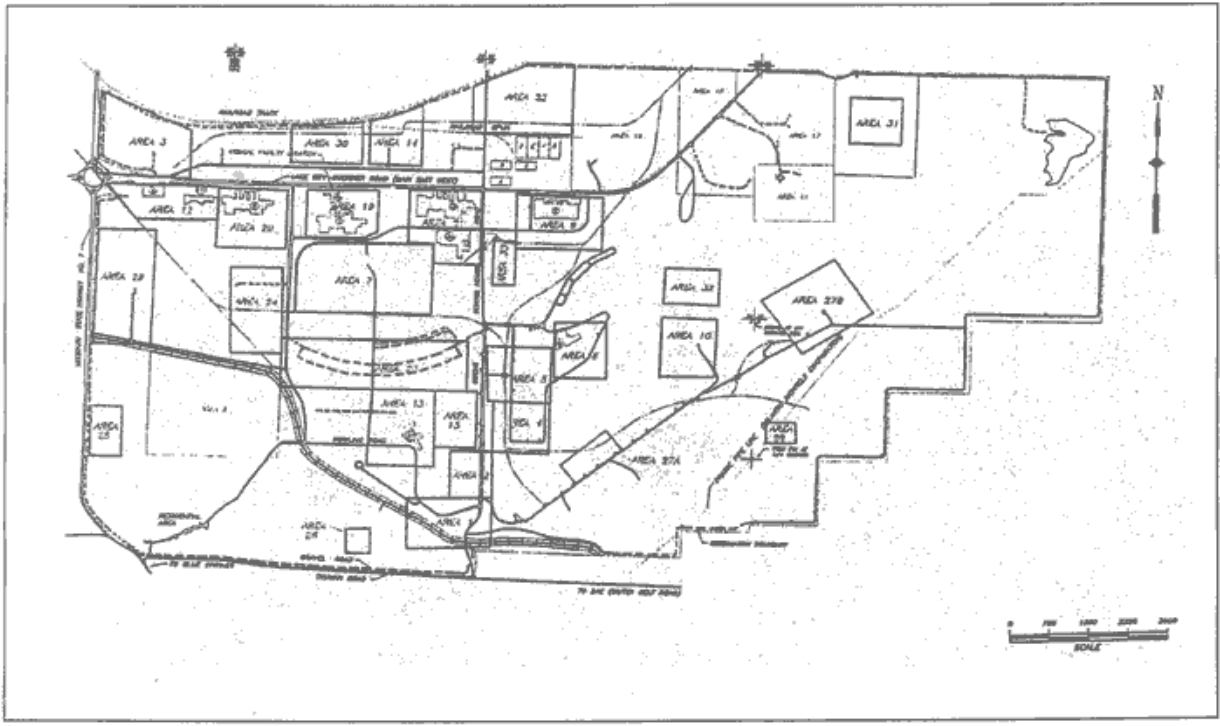
required by law and are monitored by OSHA. Such procedures are standard for any fire-fighting activity. OSHA also controls the activities of utility workers accessing any industrial area, including any which might contain hazardous waste.

FIGURE 1. LCAAP Location Map



Source:USATHAMA, 1990

FIGURE 2. LCAAP Operable Unit (OU) and Source Area Map



Source: Plexus Scientific, 1996

Figure 3. ATSDR Exposure Evaluation Process

REMEMBER: For a public health threat to exist, the following three conditions must all be met:

- People must come into contact with areas that have potential contamination
- Contaminants must exist in the environment
- The amount of contamination must be sufficient to affect people's health

Are People Exposed To Areas With Potentially Contaminated Media?

For exposure to occur, contaminants must be in locations where people can contact them.

People may contact contaminants by any of the following three exposure routes:

Inhalation
Ingestion
Dermal absorption

Are the Environmental Media Contaminated?

ATSDR considers:

Soil
Ground water
Surface water and sediment
Air
Food sources

For Each Completed Exposure Pathway, Will the Contamination Affect Public Health?

ATSDR will evaluate existing data on contaminant concentration and exposure duration and frequency.

ATSDR will also consider individual characteristics (such as age, gender, and lifestyle) of the exposed population that may influence the public health effects of contamination.